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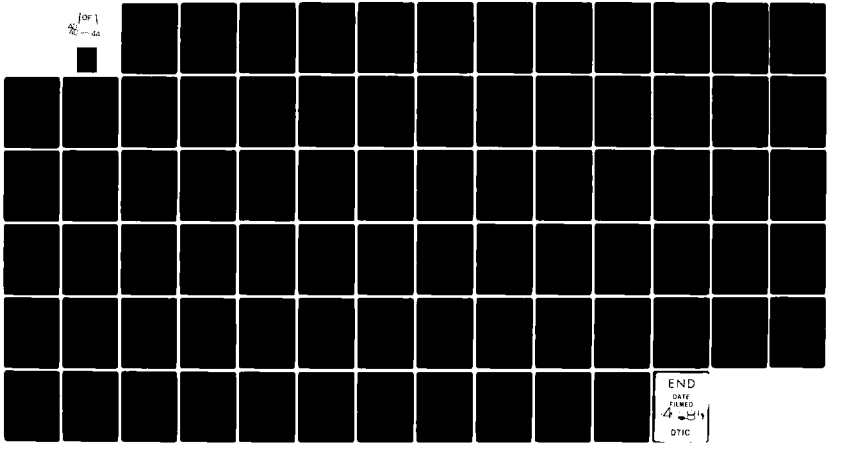

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HIGH-RESOLUTION SPECTRAL MEASUREMENT OF HIGH TEMPERATURE CO_2 AND H_2O

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This report describes results obtained in a High-Resolution Spectroscopic Study conducted on the absorption of both CO_2 and H_2O at temperatures up to 800°K. An absorption cell which gave a satisfactory performance up to 1000°K is described. Approximately 75% of the CO_2 lines observed in 2000 - 2400 cm^{-1} at 800°K are identified. The H_2O data in 1600 ~ 2000 cm^{-1} are analyzed for the line assignment, the transition frequency, and the strength.

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HIGH-RESOLUTION SPECTRAL MEASUREMENT OF HIGH TEMPERATURE CO_2 AND H_2O

Introduction

Both CO_2 and H_2O molecules are a major constituent which critically controls the infrared radiative transfer in the telluric atmosphere. Their absorption bands are distributed over a wide spectral range, extending from the far end of the infrared region to the near end. They have been extensively studied since infrared spectroscopy technology came into existence. Nonetheless, these studies did not provide complete knowledge of the infrared absorption of these two molecules. In particular, our understanding of their absorption at high temperature was rather incomplete. The bands observable at room temperature are restricted to those transitions which originate from a lower state of a relatively small excitation energy, typically from a vibrational-rotational energy below 2000 cm^{-1}. Transitions would be weak at room temperature if their lower states are insufficiently populated at that temperature. They cannot be studied well even if an extremely long absorption path is formed for their measurement. They are for most cases difficult to observe at room temperature, no matter how long the absorption path is extended. They are the transitions which originate from a lower state of high vibrational-rotational energy. They become observable when the gas temperature is raised to increase their population density to a sufficient level. These transitions, generally referred to as the hot bands, were poorly known because very few studies were conducted on them. Various experimental difficulties involved in the spectroscopic measurement of heated gas

imposed a major obstacle for pursuing the study of the hot bands. The original AFGL compilation of the atmospheric line parameters was assembled primarily for applications intended to room temperature calculation. The basic line data were derived from the room temperature data. Consequently, the accuracy which the data provided was unsuitable for the spectral synthesis calculation for high temperature. The line parameters compiled for the hot bands of these molecules do not provide an accuracy sufficient for their extrapolation to high tempe. ure. The present experimental study was intended to solve this difficulty by measuring the absorption of these molecules at elevated temperature and to improve their line parameters to such a level that they can produce a satisfactory result for the spectral synthesis at high temperatures.

The excitation which occurs in a heated gas maintains a thermal equilibrium to the molecular system; a population increase at various energy levels is controlled by the Boltzmann factor $e^{-E''/kT}$ where E" is the vibrational-rotational energy of the state in question. There would be no preferential excitations among various vibrational levels. If two states which belong to two different vibrational states have a similar energy, $E''_1 \approx E''_2$, both states are excited at an equal rate. A marked increase in the observable transitions consequently occurs along two directions as temperature of the molecular system is increased; there is a marked increase in observable vibrational transitions as well as in rotational transitions within the vibrational transition. The spectral structure consequently adds a complexity as the temperature is raised.

An increased complexity in the spectra imposes two problems: one for the spectral resolution requirement, and another for identification of the

spectral transition. The spectra must be observed with a spectral resolution of a highest degree possible. Otherwise, many transitions cannot be resolved. Their observable spectral range broadens as more rotational lines are excited within the vibration band. The problem of spectrometry is, for our case, adequately solved by use of the technique of Fourier spectroscopy. The second problem concerning identification of the observed spectral transition was found more formidable than expected. With anticipated difficulty for the identification effort, the spectral data were taken at a temperature step of 200°K, i.e., at 600°K and at 800°K. We hoped to follow the excitation of the hot bands in the data taken at these temperatures. For the H_2O data, the temperature step taken was adequate, while it was found rather inadequate for the CO_2 data. An increase of the observable CO_2 lines from 600°K to 800°K was overwhelming; at 600°K we were able to make the assignment of the observed CO_2lines without encountering serious difficulty, while at 800°K the assignment is incomplete even with an automated Loomis-Wood diagram technique which we developed for the purpose of simplifying the identification problem. A detailed description of the 800°K CO_2 data analysis is given later in this report.

Our work performed under this grant may be divided into three categories. The first category, which occupied the first phase of our effort, was to design and to construct the absorption cell which could be operated at elevated temperature. The instrumentation problem we faced during this phase was a question of the stability in the optical path at high temperature operation. With the previously acquired knowledge that the White cell configuration was totally inadequate for high temperature operation, we adopted the Pfund cell configuration, which worked very

well. The multipass optical system was found difficult to make work at high temperature. It worked within a limited temperature range even with the Pfund cell arrangement. The mirror surface coated with Rh film was adequate for the measurement at 600°K and 800°K. It was found quickly deteriorating as the temperature was raised above 1000°K. A single-pass optical configuration which requires no mirror optics seems the only arrangement which promises a successful operation at temperature above 1000°K. The work on the hot cell was published in Applied Optics. The description of the hot cell work given in this report is actually the published paper.

In parallel with the construction effort for the hot cell, our effort for reassembling the AFGL interferometer was progressed. Upon completion of the interferometer work the second category of our work, the data measurements, commenced during the summer of 1979. The absorption data of both gases were taken at two temperatures, 600°K and 800°K, over a period of approximately ten months. The data were obtained in the spectral range between 1600 ∿ 2500 cm^{-1} because of a limitation imposed by the GeAu detectors which we used for the experiment.

The third category of our work concerned the analysis of the data. Our effort for the CO_2 data taken at 600°K began in the fall of 1979. As mentioned earlier, our analysis effort went smoothly without encountering serious problems. More than 90% of the observed CO_2 lines in 2200 ∿ 2400 cm^{-1} were assigned for the vibrational-rotational transition. When the analysis was switched to the CO_2 data taken at 800°K, the situation was found rather different from what we anticipated from the 600°K data analysis. Approximately 75% of the CO_2 lines observed at this temperature were assigned for their transitions.

The analysis of the CO_2 data reconfirmed our notion that was previously held without a firm supporting evidence. A high accuracy in measurement of the line position provides practically nothing to effect an extrapolation of the rotational transition to those having a higher J value. The vibrational-rotational transitions of a linear polyatomic molecule can be given in the simple expression:

$$\sigma(J) = G + B' J'(J'+1) - D'[J'(J'+1)]^2 + H'[J'(J'+1)]^3$$
$$- B'' J''(J''+1) + D''[J''(J''+1)]^2 - H''[J''(J''+1)]^3.$$

It was found that the parameters, B, D, and H, determined from the measurement had a meaningful accuracy only within the measured transition range. They were by no means effective to predict the transitions outside the range. We found that those parameters determined from the data between P(50) to R(50) with an excellent accuracy could predict P(60) to R(60) lines with a disappointing accuracy.

The intensity of the CO_2 lines observed in the data are not determined at the moment. In complex spectral data as ours, a very few observed lines are composed of a single line transition. In dealing with the complex data we must determine the individual line intensity simultaneously for multi-line components. The assignment of the exact position for the component lines plays a crucial importance in the effort. Because of this reason, the identification of all transitions observed in the data takes a prime importance for the data analysis. We need an extended effort for the transition assignment.

The H_2O data contrasted in many ways from the CO_2 data. The H_2O molecule is an asymmetric top rotor; the rotational lines are distributed in a manner not as simple as a linear molecule. Its vibrational frequencies are much larger than those of CO_2. Even though the H_2O spectrum contains

far less lines than the CO_2 spectrum, its structure is far more complex than the latter. Nonetheless, our analysis effort went well. The identification of the transition, as well as the intensity were determined using the 800°K data.

The obtained results are separately discussed below, one for the CO_2 work and another for the H_2O. Mark Esplin carried out the CO_2 work for his Ph.D. research. The H_2O work was done by Hajime Sakai. The computational effort involved in the data analysis was assisted by Shui-Hua Li. Both the CO_2 and H_2O data measurements were taken by Mark Esplin and William Dalton.

The report consists of three independent parts: the work on the high temperature absorption cell published in Applied Optics, the analysis of the CO_2 data taken at 800°K, and that of the H_2O data taken at the same temperature. The second part is a brief summary of the dissertation that Mark Esplin will complete in the near future. The third part is a preprint of a paper to be published.

Throughout the entire grant period, we made four presentations at professional meetings: two papers at the Symposium on Molecular Spectroscopy held at the Ohio State University, one at the HIRAD meeting held at the National Bureau of Standards, and one at the OSA Topical Meeting on Spectroscopy in Support of Atmospheric Measurement.

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Absorption cell for the infrared spectroscopy of heated gas

William S. Dalton and Hajime Sakai

A Pfund-type absorption cell that exhibits extreme stability at high temperature has been constructed for use with high-resolution Fourier spectroscopy. The cell is currently used to measure the absorption spectra of CO_2 and H_2O gas samples heated to 1300 K. The advantages of the Pfund cell are described with respect to that of the White cell for use in Fourier spectroscopy.

I. Introduction

In the IR region, very few studies have been conducted on the absorption spectroscopy of heated gases. Atmospheric molecules CO_2 and H_2O have been studied up to 1000 K with relatively low spectral resolution.[1] The information obtained by these early high temperature measurements provided a valuable contribution, not only to the understanding of the hot-band transitions in specific but to the molecular physics of these molecules in general. Although the merit of these studies has been well recognized, the difficulties involved in the experiment provided little encouragement for its vigorous pursuit. Prior to recent advances in the IR spectrometric technique, the optical design required for the operation of the absorption cell at a high temperature of ~1000 K was rather difficult. To a large extent, this difficulty was solved with our newly constructed cell. In this paper, we will describe our cell, which performs very well for its intended use, i.e., high-resolution absorption spectroscopy of H_2O and CO_2 at high gas temperatures. It was found satisfactory for producing the spectroscopic data taken at a gas temperature of 800 K with a 0.006-cm^{-1} resolution. Our design approach, the testing conducted on various elements, and the spectroscopic data obtained with it will be reported.

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II. Cell Design

Long-term stability to maintain a stationary optical output is a prime factor required for the absorption cell, which is used with high-resolution Fourier spectroscopy. An absorption cell operating at a high temperature is subjected to severe mechanical strain. Our preference of the Pfund configuration[3] over the White configuration[4] is based on the required stability. The White configuration, which is designed to provide a flexible optical path by adjusting the mirror alignment, is inherently unstable in a long-term operation. The mirror mounts are necessarily complicated to furnish a certain adjustable setting of the mirrors. They cause a significant drift upon a slow accumulation of the mechanical strain. In the high temperature operation, a build-up of the mechanical strain is more accentuated, as the structural temperature is raised from room temperature to that desired for the operation. We found it almost impossible to design a mirror mount that would meet our requirements. The Pfund configuration, shown in Fig. 1, is much less adaptable than the White configuration in providing a flexible optical path, although it can provide some degree of flexibility. The optical configuration allows no internal adjustment, and the number of passes must be adjusted by means of the external optical scheme. Once the mirrors are properly mounted in the cell, they are held at their position securely. A drift in the optical output results only if the cell body deforms severely. Thus, stability is well furnished in the design. In addition, the stability for maintaining the stationary optical output is further improved by our design, which is to separate the heating element from the absorption cell body. The cell structure is constructed separately and placed in the furnace. The space between the furnace inner wall and

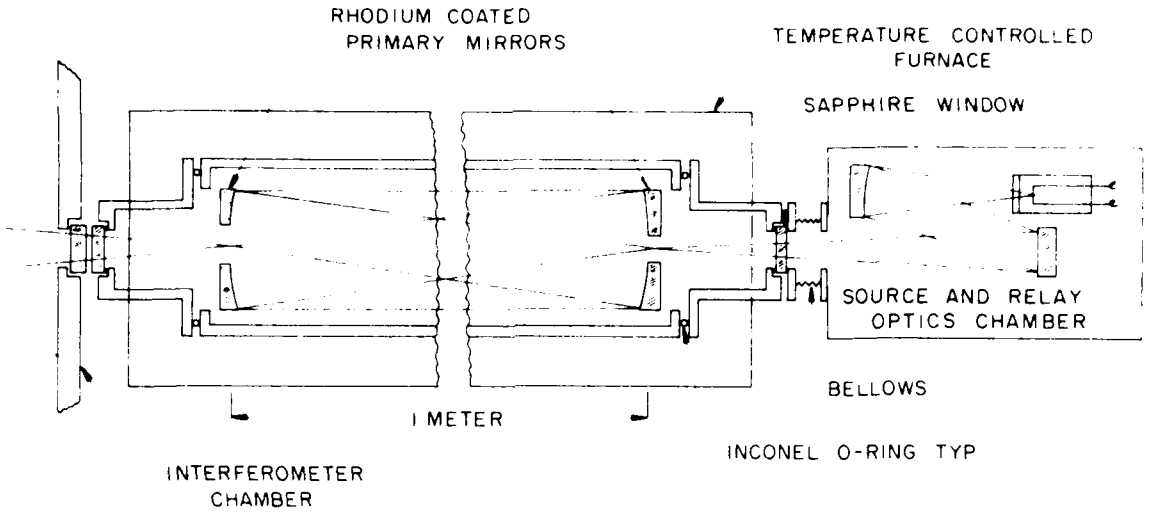

Fig. 1. High temperature absorption cell.

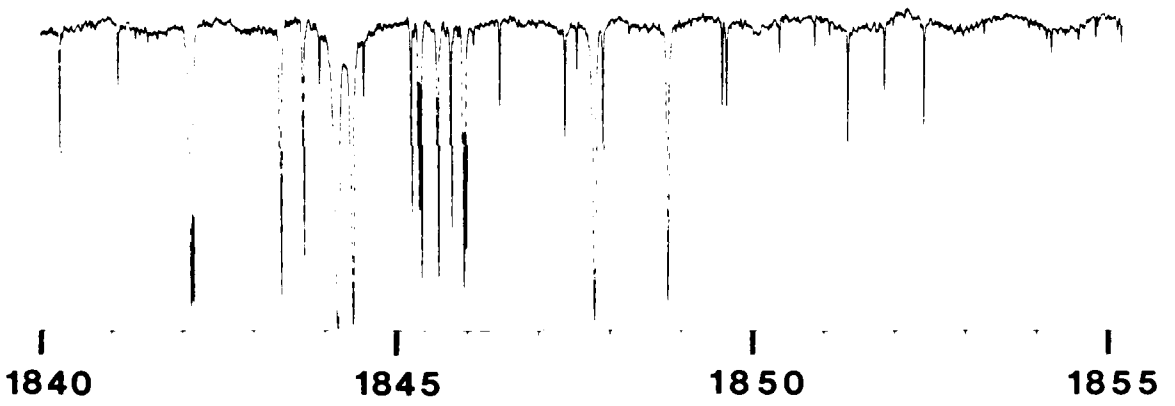

Fig. 2. Spectrum of H_2O taken in the 1840–1855-cm^{-1} region with 0.006-cm^{-1} resolution, 6-Torr H_2O pressure, and 600-K temperature. The figure shows a short section of the entire data taken in the 1600–2400-cm^{-1} region.

the cell body provides a thermal cushion. A heat flow between them is smoothed out in this configuration, even if the control circuitry to the furnace for maintaining the operating temperature undergoes on-off cycles rather frequently.

The cell body was constructed of series 310 stainless steel (AISI code), which has a sublimation temperature of ~1650 C, well above our maximum operating temperature. The material was selected because of its easy machinability and desirable characteristic for welding. It is reasonably stable at high temperature: a low thermal expansion coefficient (1.4×10^{-5} cm^{-1} ($^{\circ}$-1)) and an excellent atmospheric resistance to scaling. We noticed a slightly increased chemical reaction of this stainless steel to H_2O and CO_2 at temperatures >600 K. The gas pressure in the cell gradually decreases at a slow rate, but it does not significantly interfere with the measurements.

The interferometric configuration used in Fourier spectroscopy makes the spectrometric efficiency very high compared with the conventional configuration. We, therefore, can afford some loss in the optical throughput of the hot cell. The optics in the final form was an $f/14$ beam with a mirror separation distance of 1 m, achieving a 3.5-m path between both entrance and exit ends. The mirror substrate was tested for surface

stability with an Rh film coating as well as for a chemical reaction at high temperature operation. We chose clear synthetic fused silica after a series of tests conducted on prepared samples of fused silica, Corning Glass Works premium grade Cervite C101 and General Electric Ultra Low Expansion glass, in a small furnace with temperatures cycling between ambient room temperature and 1300 K. The fused silica and the ULE sample fared well in the test, showing no appreciable deterioration, while the Cervite did not.

The standard coatings for IR mirrors such as Al, Ag, and Au are unusable at the operating temperature required for the measurements. A test was conducted on the effect of the temperature to the reflectivity of rhodium. The reflectivity of a 500-Å thick Rh film deposited on several pieces of polished silica was measured in the 2–6-μm region prior to the heating test. After heating them to 600 K for a period of 24 h, letting them cool, and measuring their reflectivity under identical conditions as those prior to heating, we detected a deterioration of ~10% in reflectivity. The same procedure was followed for temperatures of 900 and 1300 K, and the deterioration in reflectivity was found to be 30 and 70%, respectively. The Rh coating remained attached to the substrate but became discolored at 1300 K. Although this is considered far from an ideal situation, the throughput of our system is more than adequate to make up for the loss. (The deterioration of the mirrors with temperature would be disastrous for a multiple-traversal operation.) Two of these mirrors have been in use ~6 months at 600 K, and we observed about a 10% degradation in signal level, which occurred at the first use of the system.

The mirrors were mounted on a standard 3-point mirror holder with a ceramic fiber backing. The thin section of fiber gave the mirror just enough freedom of movement to prevent cracking. Also, the continuous filament ceramic fiber, brand AB-312 manufactured by the 3M Company, has good chemical resistance and dimensional stability at temperatures >1300 K.

Most of the window crystals transparent in the IR region are not heat resistant. They are so fragile that hard contact to a hot metal frame is unworkable. No technique has been developed for providing a delicate mount for these crystals onto the hot metal structure. The only choice left to us is to mount the window crystal on the lukewarm frame using an O ring or a gasket made of pliant material. Our design places both end sections of the cell outside the furnace. The windows are cooled either by natural convection heat loss or by forced coolant circulation. The window crystals are mounted to the cell body through a silicon O ring, forming a vacuum-tight seal. With the main section of cell being heated at 600 K, the window portion remains at ~330 K. The temperature distribution in the cell is quite uniform with ±2 K over the entire length except in the proximity of ~10 cm to the window where the temperature drops very rapidly. The cell is made of three sections as shown in Fig. 1; both ends of a main central section are connected through a gas-filled Inconel O ring to a short end section on which the window is mounted. The structure enables us to access the mirror for alignment as well as for replacement purposes. The system has remained tight during the past 6 months of operation.

III. Furnace

The main factor in the consideration to separate the absorption cell and the furnace has been described already. Our design was certainly influenced by a well designed furnace readily available on the commercial market. It is manufactured by the Mellen Company, Webster, New Hampshire. The heat output of the furnace is controlled by thermocouples placed inside the wall of the absorption cell. The cell temperature is controlled within ±2 K over the entire measurement period. This arrangement is convenient in that the cell can be easily accessed for replacement and/or repair. The positional stability of the overall structure is well demonstrated in the data obtained.

IV. Results and Conclusions

Since the absorption cell was completed, we have been vigorously taking the spectroscopic data of heated gas. Figure 2 shows a part of the data taken with H_2O pressure of 6 Torr at 600 K. It is a short portion of the entire spectrum that covered from 1600 to well over 2200 cm^{-1} with a 0.006-cm^{-1} spectral resolution. The spectrometry achieved is judged by the quality factor defined by Connes:

$$Q = (s/n)\,\text{spectrum}\left(\frac{\text{spectral coverage}}{\text{resolution}}\right).$$

The quality factor of the data shown in Fig. 2 is ~10^7. The interferogram measurement takes ~10 h to cover the optical path difference of 80 cm.

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II. CO_2

The importance of CO_2 as an atmospheric molecule makes the obtaining of high precision band parameters for a great number of bands a significant contribution to both theoretical and experimental studies of our atmosphere. Very accurate parameters on the (00001-00011)* band of $^{12}C^{16}O_2$ have been obtained by Pine and Guelachvili.[1] Their measurement was accomplished by combining two spectra, a room temperature Fourier transform spectrum and a high temperature tunable laser spectrum. There have been numerous measurements of other bands of CO_2, but they were made either with lower resolution spectrometers, or near room temperature where fewer rotational lines were excited,[2,3] resulting in a less accurate determination of band parameters. In this work a high resolution Michelson interferometer was coupled with a high temperature absorption cell heated to 800°K to obtain a high resolution (0.007 cm^{-1}), high temperature spectrum of CO_2 in the 4.3 micron region.

The energy of a linear molecule in a given vibrational-rotational state can be represented by

$$E(\nu,J) = G(\nu) + B[J(J+1)] - D(\nu)[J(J+1)]^2 + H(\nu)[J(J+1)]^3$$

where ν is the quantum number associated with vibrational energy, J is the quantum number associated with total angular momentum of the molecule, and $G(\nu)$, $B(\nu)$, $D(\nu)$, and $H(\nu)$ are the band parameters. The infrared spectrum corresponds to the transitions between different vibrational-rotational states.

The advantages of taking the measurements at an elevated temperature are twofold. First, at the higher temperature more rotational lines are

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*For CO_2 there are three fundamental modes of vibration, ν_1, ν_2, and ν_3. Associated with the bending mode, ν_2, is the angular momentum ℓ. The notation used is $\nu_1\nu_2{}^{\ell}\nu_3 r$ where r is the ranking index for a Fermi resonating group.

excited, making it possible to obtain higher precision in the determination of the spectroscopic constants $G(v)$, $B(v)$, $D(v)$, and $H(v)$. Secondly, the higher temperature results in higher vibrational energy levels being excited, making more of the so-called "hot bands" visible.

We used a PDP-8e mini-computer to control the interferometer and to sample the interferogram. The data was taken via magnetic tape to be analyzed using the CDC 6600 computer at the University of Massachusetts in Amherst. The data was first Fourier transformed, the various lines identified, and finally a least-square-fit technique was used to generate new values for the band parameters. Each band was fit independently of the other bands.

Spectra obtained using high resolution Fourier transform spectrometers have an excellent frequency stability over a wide spectral range. There is, however, a small systematic frequency shift introduced into the spectra due to finite detector size.[4] In principle, this correction can be calculated from the geometry of the interferometer apertures and detectors, but in practice it is usually easier to use an internal frequency standard. Lines due to CO were present in our experimental spectrum. Guelachvili has measured the position of these CO lines with an accuracy of 0.00008 cm^{-1}.[5] We used these line positions as an internal frequency standard. After this systematic error was removed from our spectra, the standard deviation of the fit between our data and Guelachvili's, on well isolated lines, was about 0.0004 cm^{-1}.

One disadvantage of taking spectral measurements at high temperatures is the difficulty of constructing a high temperature absorption cell that is mechanically stable, and whose structural materials can withstand the high temperature. The absorption cell used in this work has previously been

described in more detail.[6]

Another complication that arises in working with high temperature spectra of CO_2 is the large number of lines present. Tens of overlapping bands, each consisting of hundreds of lines, result in an observed line density of over 20 lines/cm^{-1}.

The identification was made in one of three ways, depending on how well the band had previously been measured. For well known bands the identification procedure was readily automated. The position and strength of each line was calculated, and then used to locate the line in the experimental spectrum with approximately the right strength that was closest to the calculated position.

For other bands, the positions of lines for low J have been well measured, but not for high J. In this case, the line positions were again calculated and the experimental lines identified, starting at low J and moving up to higher J, until there were not any lines within about 0.02 cm^{-1} of the calculated line. The band was then refit and new constants obtained. The process was iterated until no further extension to higher J was possible.

In some cases the band was so poorly known even at low J that the identification could not be made by taking the experimental line closest to the calculated line position. Another problem arose when certain combinations of merged lines made the extension from low J to higher J impossible. In these two cases, a Loomis-Wood diagram[7] approach has been extremely helpful in picking out the lines that belong to one band in the presence of lines belonging to other bands. When the differences between a calculated line and all observed lines that are nearby are displayed graphically, it is relatively easy to see the pattern created from a set of lines which have band parameters similar to those used to calculate

the line positions.

After the identification of lines was determined, each band was fit throwing out only the most severely merged lines. Lines for which the difference between the observed and calculated position was less than about 0.005 cm^{-1} were kept in the fit. All lines used in the fit were weighted equally. The bands that were fit are given in Table I, along with the standard deviation, the range of J values used, and the total number of lines used in the fit. The resulting values obtained for G(v'), G(v"), B(v'), D(v'), H(v'), B(v"), D(v"), and H(v") are tabulated in Table II.

Several constraints were used on the fits. The constants H(v') and H(v") are given as zero. For bands with ℓ greater than or equal to two, both the C and the D bands were fit together. For bands with ℓ equal to two, the parameters G(v'), G(v"), B(v'), and B(v") were held common for both bands, where the parameters D(v'), D(v"), H(v'), and H(v") were allowed to be dissimilar for the two bands. For bands with ℓ greater than two, the C and the D bands were fit entirely together, with no distinctions between the two bands.

The difference between the band parameters determined by Guelachvili, and the AFGL line compilation, for the P branch of the 02201-02211 band of $^{12}C^{16}O_2$ have been compared to the band parameters as shown in Figure 1. Guelachvili made extremely accurate room temperature measurements (0.0001 cm^{-1}) of the position of lines up to about J = 46 of this band, from which he calculated band parameters.[8] For low J (less than 50), the agreement with this work is excellent, but for high J the difference is large.

The large values of the standard deviations given in Table II, considerably greater than the 0.0004 cm^{-1} for well isolated lines mentioned

earlier, are caused by merging of lines. Most observed lines are merged to some degree. If lines causing merging belong to bands that are not correlated with the band being fit, the effect of the merged lines will be an increase in the random scatter of the fit. It is very rare to have both the position and the spacing between the lines of the band being fit and lines in a merging band close enough that significant correlation occurs. The strongest correlation between bands in the observed spectrum appears to be between C and D bands. For example, the 01101C-01111C and the 01101D-01111D bands have spectroscopic constants just enough different that even though they have the same band origin, R(105) of the C band is merged with R(106) of the D band. At this point in the bands, the difference between the line spacing is only 0.005 cm^{-1}, yet R(102) is not merged with R(104), or R(107) is not merged with R(108). The smallness of the correlation between bands supports the assumption that fitting partly merged lines is valid.

To further insure that the identification and fitting procedure was valid, a synthetic spectrum was calculated and compared to the observed spectrum. The band parameters listed in Table II and the band intensities given in reference 9 were used to create the synthetic spectrum. Bands that resulted in higher absorption in the synthetic than in the observed spectrum were either refit or thrown out entirely.

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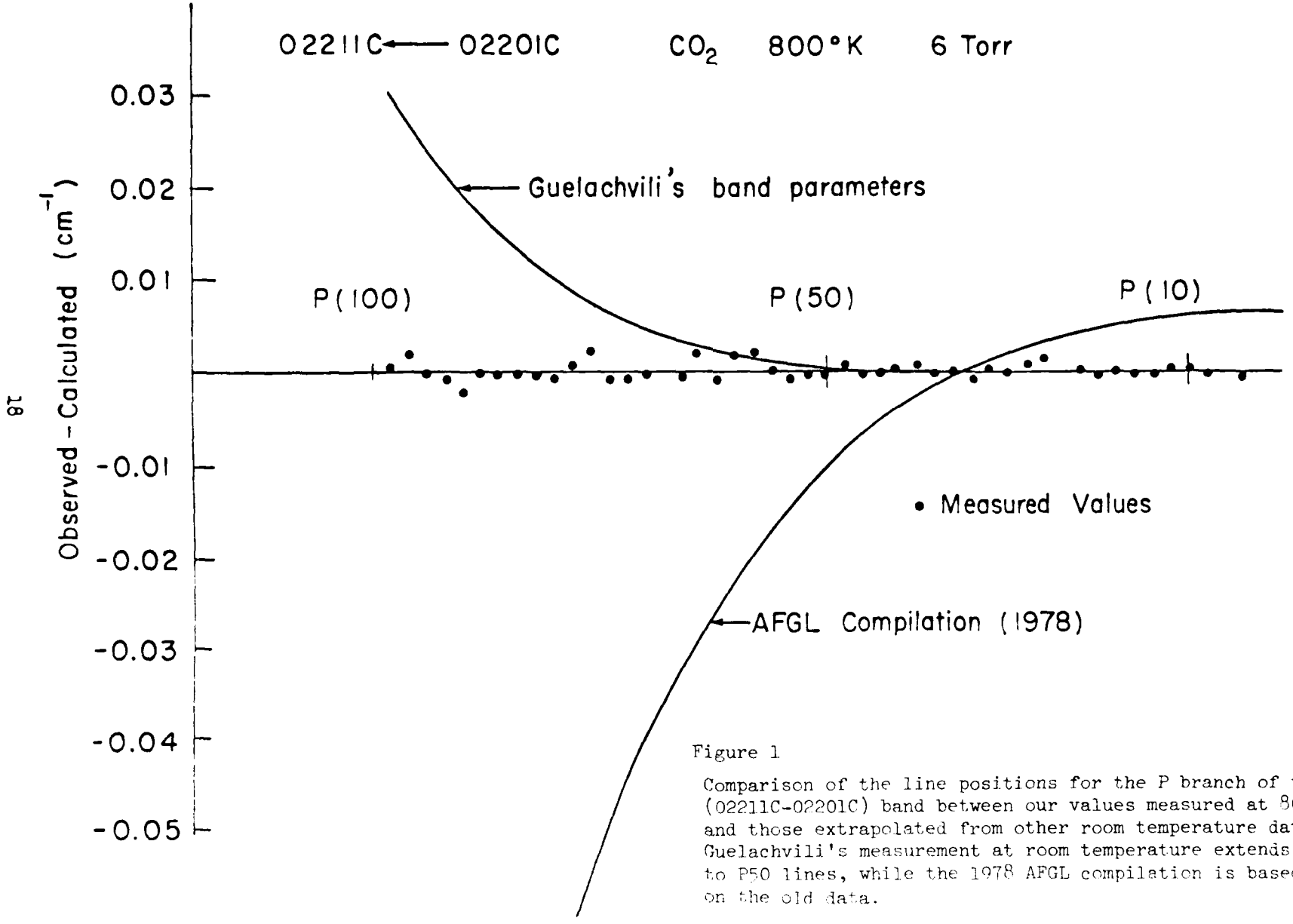

Figure 1

Comparison of the line positions for the P branch of the (02211C-02201C) band between our values measured at 800°K and those extrapolated from other room temperature data. Guelachvili's measurement at room temperature extends up to P50 lines, while the 1978 AFGL compilation is based on the old data.

Table I

The CO_2 bands studied in the present work.

Transition													Isotope	Band Center (cm^{-1})	Range of Measurement
0	0	0	1	1			0	0	0	0	1		626	2349.1430	P120-R118
0	1	1	1	1	C		0	1	1	0	1	C	626	2336.6330	P107-R107
0	1	1	1	1	D		0	1	1	0	1	D	626	2336.6330	P108-R104
1	0	0	1	2			1	0	0	0	2		626	2327.4330	P102-R102
0	2	2	1	1	C		0	2	2	0	1	C	626	2324.1410	P98-R104
0	2	2	1	1	D		0	2	2	0	1	D	626	2324.1410	P105-R107
1	0	0	1	1			1	0	0	0	1		626	2326.5980	P104-R104
1	1	1	1	2	C		1	1	1	0	2	C	626	2315.2350	P67-R63
1	1	1	1	2	D		1	1	1	0	2	D	626	2315.2340	P86-R88
0	3	3	1	1			0	3	3	0	1		626	2311.6680	P90-R92
1	1	1	1	1	C		1	1	1	0	1	C	626	2313.7720	P89-R87
1	1	1	1	1	D		1	1	1	0	1	D	626	2313.7720	P88-R88
2	0	0	1	3			2	0	0	0	3		626	2305.2570	P80-R76
1	2	2	1	2	C		1	2	2	0	2	C	626	2302.9580	P68-R62
1	2	2	1	2	D		1	2	2	0	2	D	626	2302.9580	P67-R67
0	4	4	1	1			0	4	4	0	1		626	2299.2140	P82-R83
2	0	0	1	2			2	0	0	0	2		626	2306.6900	P86-R56
1	2	2	1	1	C		1	2	2	0	1	C	626	2301.0530	P86-R88
1	2	2	1	1	D		1	2	2	0	1	D	626	2301.0530	P83-R83
0	0	0	2	1			0	0	0	1	1		626	2324.1830	P93-R87
2	0	0	1	1			2	0	0	0	1		626	2302.5230	P82-R78
0	0	0	1	1			0	0	0	0	1		636	2283.4870	P82-R82
0	1	1	1	1	C		0	1	1	0	1	C	636	2271.7590	P71-R61
0	1	1	1	1	D		0	1	1	0	1	D	636	2271.7610	P74-R58
1	0	0	1	2			1	0	0	0	2		636	2261.9110	P56-R58
0	2	2	1	1	C		0	2	2	0	1	C	636	2260.0520	P50-R46
0	2	2	1	1	D		0	2	2	0	1	D	636	2260.0520	P53-R51
1	0	0	1	1			1	0	0	0	1		636	2262.8460	P54-R48
2	1	1	1	2	C		2	1	1	0	2	C	626	2293.4110	P71-R71
2	1	1	1	3	D		2	1	1	0	3	D	626	2293.6100	P76-R74
0	1	1	2	1	C		0	1	1	1	1	C	626	2311.7030	P90-R80
0	1	1	2	1	D		0	1	1	1	1	D	626	2311.7000	P83-R79
1	0	0	2	2			1	0	0	1	2		626	2302.3690	P69-R65
0	2	2	2	1	C		0	2	2	1	1	C	626	2299.2400	P75-R93
0	2	2	2	1	D		0	2	2	1	1	D	626	2299.2380	P78-R80
0	5	5	1	1			0	5	5	0	1		626	2286.7770	P66-R66
1	3	3	1	1			1	3	3	0	1		626	2288.3900	P65-R63
1	3	3	1	2			1	3	3	0	2		626	2290.6800	P73-R66

TABLE II (All are in cm^{-1})

Band			G"	G' - G"	B'	D'x10^7	H'x10^{-13}	B"	D"	H"	SGx10-4
00011	00001	626	0.000	2349.143	.38713745	1.32514	- .1	.39021480	1.32815	- .1	9
01111C	01101C	626	667.379	2336.633	.38759128	1.34823	.3	.39063793	1.35387	.2	7
01111D	01101D	626	667.379	2336.633	.38818885	1.35624	.2	.39125338	1.35978	.2	6
10012	10002	626	1285.409	2327.433	.38750303	1.57182	1.9	.39048172	1.56621	1.8	8
02211C	02201C	626	1335.129	2324.141	.38863751	1.37657	- 2.2	.39166830	1.39112	- 2.4	9
02211D	02201D	626	1335.129	2324.141	.38863751	1.38347	.8	.39166830	1.38995	.8	9
10011	10001	626	1388.187	2326.598	.38706354	1.14847	2.3	.39018922	1.15526	2.3	9
03311	03301	626	2003.238	2311.668	.38937836	1.39742	- .4	.39038084	1.41110	- .3	9
11111C	11101C	626	2076.865	2313.772	.38735962	1.21874	- 1.2	.39040322	1.23269	- 1.5	9
11111D	11101D	626	2076.865	2313.772	.38822645	1.17343	- 2.4	.39132451	1.18134	- 2.4	12
00021	00011	626	2349.141	2324.183	.38406499	1.31129	- 2.3	.38714060	1.31706	- 1.9	7
20013	20003	626	2548.373	2305.257	.38818763	1.79054	3.8	.39110066	1.79227	3.9	13
12212C	12202C	626	2585.032	2302.958	.38894365	1.35669	0.0	.39193107	1.39145	0.0	26
12212D	12202D	626	2585.032	2302.958	.38894365	1.48755	0.0	.39193107	1.52141	0.0	26
20012	20002	626	2671.146	2306.690	.38652310	1.35362	10.6	.38954825	1.32130	4.6	13
04411	04401	626	2671.690	2299.214	.39010454	1.39091	- 1.6	.39307315	1.41071	- 1.7	10
12211C	12201C	626	2760.735	2301.053	.38853501	1.34651	-15.0	.39155785	1.39571	-15.0	10
12211D	12201D	626	2760.735	2301.053	.38853501	1.32085	6.6	.39155785	1.33752	6.2	10
20011	20001	626	2797.154	2302.523	.38747238	.87851	- 4.5	.39057680	.87891	- 4.7	11
01121C	01111C	626	3004.016	2311.703	.38456350	1.40044	6.6	.38761095	1.41327	7.3	13
01121D	01111D	626	3004.016	2311.700	.38512829	1.34465	- 1.2	.38818842	1.34087	- 2.0	14
13312	13302	626	3240.564	2290.680	.38971034	1.47398	0.0	.39265318	1.48599	0.0	13
13311	13301	626	3442.256	2288.390	.38924068	1.31704	0.0	.39220963	1.36731	0.0	14
10022	10012	626	3612.840	2302.369	.38452333	1.66712	17.0	.38748663	1.58073	3.0	18
02221C	02211C	626	3659.277	2299.240	.38560401	1.32035	5.4	.38863983	1.36655	8.4	13
02221D	02211D	626	3659.277	2299.238	.38556943	1.28275	- 6.1	.38859689	1.28382	- 6.4	12
00011	00001	636	0.000	2283.487	.38727283	1.32429	- .2	.39023617	1.32660	- .3	9
01111C	01101C	636	648.484	2271.759	.38767594	1.29905	- 8.8	.39060610	1.30527	- 8.2	11
01111D	01101D	636	648.484	2271.761	.38828278	1.31849	- 2.6	.39123536	1.33090	- 1.5	12
10012	10002	636	1265.820	2261.911	.38803282	1.55644	- 9.9	.39091903	1.61192	1.2	13
02211C	02201C	636	1297.269	2260.052	.38870822	1.58213	0.0	.39162783	1.59020	0.0	15
02211D	02201D	636	1297.269	2260.052	.38870822	1.37269	0.0	.39162783	1.39569	0.0	15
10011	10001	636	1370.067	2262.846	.38676005	1.30651	0.0	.38975035	1.29713	0.0	16

$\underline{H_2O}$

The infrared absorption of H_2O is one of the most intensively measured spectroscopic data. Since the infrared spectrometers capable of a spectral resolution exceeding 0.1 cm^{-1} were developed in the 1950's, the H_2O spectra throughout the entire infrared range were measured with a majority of the lines resolved. Both study efforts, experimental and theoretical, were progressed in parallel with development of the high-resolution infrared spectroscopy. A principal object of the experimental effort was to make a high precision measurement of the transition frequencies, the strengths and the widths, while that of the theoretical effort was to furnish the proper assignment for the observed transitions, as well as the calculated values for the transition parameters in a good agreement with the observed data. By the early 1970's the experimental data were accumulated in a sufficient quantity so that the global compilation of the H_2O line data throughout the infrared spectral region became possible. In 1973, the group headed by the late William S. Benedict accomplished the monumental compilation of the H_2O line data which was a major achievement included in the AFGL atmospheric line listing.[1] With these line data, for the first time in fifty years of infrared spectroscopy, we had access to a global knowledge of the infrared H_2O transitions. Since the early 1970's, infrared spectrometry went through another revolutionary advance. The spectral resolution achieved in the data measurement was improved by one to two orders of a magnitude. The data measurement became very efficient; a high quality spectrum which contains $10^5 \sim 10^6$ spectral elements was obtained in a routine measurement of several hours duration. The position of the transition lines became known to an accuracy within $\pm .001$ cm^{-1}. Both the advance in spectrometric technique and the extensive compilation of the spectroscopic line data in

turn provided a strong incentive for re-examination of the AFGL H_2O line data compilation. The consequent improvement in the current AFGL compilation was based on a series of theoretical works carried out by Flaud and Camy-Peyrot.[2] The listed position of the H_2O transitions observable at room temperature gained an accuracy figure better than ± 0.01 cm^{-1}.

The transitions observable at room temperature are those which have a lower state energy below 2000 cm^{-1}. The transitions which start from the initial lower state of a higher vibrational-rotational energy are weak at room temperature, because the lower state is insufficiently populated. They become observable as the lower state population is increased by means of thermal excitation. They are commonly called the "hot band" lines because their absorption increases with rising gas temperature. The list of the H_2O energy levels compiled in the work of Flaud and Camy-Peyrot provides an insufficient coverage for the study of the hot band lines. In the past, a majority of the H_2O spectral study was conducted on the absorption data taken at room temperature. A very few studies were made on the high temperature absorption data.[3] In 1600 $\sim$ 2000 cm^{-1}, no studies were carried out on the high temperature H_2O absorption. The present experimental study was intended to remove this deficiency and to fill the need for improvement of the hot-band line data in this spectral region by measuring the absorption spectrum of H_2O at elevated temperature.

Experimental

The experimental arrangement for the present study was already described elsewhere. The following description summarizes the information pertinent to the present study. The spectrometer used for the data measurement was a cat's eye type Michelson interferometer designed to measure the interferogram data

using the step-and-integrate scanning mode.[4] The data were sampled with a multiple of an interference fringe distance by the single mode cw He-Ne laser line at 6329.9A in vacuum. The interferometer was operated in vacuum. The laser line was stabilized by the Lamb dip at the center of the laser transition.[5] The spectral data was expected to exhibit a downward frequency shift by 0.0020 cm^{-1} in 2000 cm^{-1} region because of a finite aperture size of the detector used.[6] The parasitic CO lines observable in the data were used as the internal standard for the wavenumber calibration. The measured positions of the CO lines were .00206 cm^{-1} in average lower than the values published by Guelachvili.[7] All of our measured wavenumber figures were accordingly adjusted to include the constant shift of -.00206 cm^{-1}. The spectral resolution of the data was .0060 cm^{-1}.

The high temperature absorption cell[8] was connected to the interferometer optics placed in vacuum via a short air space of approximately .25 cm, which was the only path exposed to the ambient environment. The rest of the optical path connecting the source to the interferometer via the absorption cell was kept in a pressure below 1 torr. The H_2O pressure in the absorption cell was measured by the Baratron pressure gauge.

Absorptance Spectra

The observed data for our study contained a 100% transmittance-level rather non-uniformly varied as a function of the wavenumber. The variation resulted from several factors, the change in the spectral sensitivity of the detector, the spectral transmission characteristics of the bandpass filter, and so forth. The most troublesome background level modulation was caused by the interference of the various optical surfaces through which the infrared beam was transmitted. The H_2O absorptance was determined against the non-uniform 100% transmission level. Various computation logics were

employed to determine the 100% transmittance level in hope for reducing any speculative aspect to a minimum level. In the end, there still existed some degree of speculation in determination of the absorptance, possibly amounting to 5% in average.

Data Analysis

The absorptance spectra thus determined were at first analyzed for the transition frequencies. Since the data points were spaced at a finite resolution interval given by an inverse of twice the maximum optical path difference, smooth contour generated by interpolating these data points was used for the data analysis. The line centers were determined using the first and the second derivative calculated from the interpolated spectral data. The uncertainty in the line center frequency was affected by the noise in the data as well as by the blending of the neighboring lines. The uncertainty figure was larger for the lines which were strongly saturated at the center, even for the case where they were well isolated from their neighbors. The over-all uncertainty figure in the measured transition frequency was a value close to the smallest interval used in the interpolated data, 0.0004 cm^{-1}. No special effort was taken to improve the uncertainty figure beyond this limit.

The absorption contour of the molecular transition in the observed spectra is expressed in a good approximation by a convolution integral of the true absorption contour and the impulse response of the instrument, commonly called the instrument function. For the spectrum obtained by using the technique of Fourier spectroscopy, it is more conveniently expressed in a form of the interferogram, defined in the optical path difference scale x, rather than in a form of the spectrum, defined in the wavenumber scale σ. The observed contour $A'(\sigma)$ and the true contour $A(\sigma)$ are

related by

$$\int A'(\sigma)\, e^{i2\pi\sigma x}\, d\sigma = \{\int A(\sigma)\, e^{i2x\sigma x}\, d\sigma\}\, T(x), \qquad (1)$$

where $T(x)$ is a multiplicative function of a finite extension which is caused by the interferogram data coverage limited to the maximum optical path difference X. The function $T(x)$ takes a special shape dependent on the type of the apodization applied to the spectral data. For our case, it is a triangular function tapered to zero at the maximum path difference X;

$$T(x) = 1 - \frac{|x|}{X} \qquad \text{if } |x| \leq X,$$

and

$$= 0 \qquad \text{if } |x| > X. \qquad (2)$$

The true absorptance contour of a well-isolated molecular transition line is expressed by

$$A(\sigma) = 1 - \exp\,[-k(\sigma)] \qquad (3)$$

where the function $k(\sigma)$ is called the absorption coefficient defined by the transition strength S per a single molecule in a form

$$\int k(\sigma)\, d\sigma = SN. \qquad (4)$$

In this formulation we assume that the absorption is caused by a uniform column of N total molecules per a unit cross-sectional area. If the thermal equilibrium exists along the absorption path, the strength S is written in a well known formula:

$$S = \frac{8\pi\nu}{3hc}\,|R|^2\,(1-e^{-\frac{h\nu}{kT}})\,\frac{1}{g}\,e^{-E''/kT}$$

where ν is the transition frequency in Hz, R is the transition moment, g is the statistical weight of the lower state, and E" is the lower state energy. The absorption coefficient $k(\sigma)$ takes various shapes subject to the line profile. If we can assume that the collisions from the neighboring molecules dominate the broadening process of the transition line, we can express the absorption coefficient by the Lorentzian profile:

$$k(\sigma) = \frac{S\alpha}{\pi[(\sigma-\sigma_o)^2 + \alpha^2]}, \tag{5}$$

where α is the width and σ_o is the center frequency of line.

The observed spectrum for most cases contains the lines overlapped by their neighbors. The absorptance contour for the overlapped lines is given by

$$A(\sigma) = 1 - \exp - [\sum_{n=1}^{N} k_n(\sigma)], \tag{6}$$

where the absorption consists of N lines, and $k_n(\sigma)$ is the absorption coefficient for the n-th line. The data which we deal with in the analysis contain the situations from one extreme to another, i.e., from the case for well isolated lines to the one containing many overlapping lines. Our objective in the spectral analysis is to determine the line parameters of each transition, the transition frequency σ_o, the strength S and the width α. The following discussion covers a technique used for extraction of these parameters when the data to be analyzed contain the line overlapping.

The first step in the analysis was to separate the data into groups of lines which were sufficiently isolated from others, and then the second step was to apply the curve fitting technique based on the least-square method. The first process was necessary because the data contained a variable degree of line overlapping. The groups were separated by a sufficient zero absorptance interval from their neighbors at their both sides. With the line center frequency determined as described above, the remaining two variables for each component line, the strength and the width, were determined under the assumption that the line profile was Lorentzian. A spectral pattern theoretically constructed using the Lorentzian profile with assumed parameters was compared with the observed data. The square error between them was calculated and then it was

minimized by adjusting the two variables, the strength and the width, for each component line. The sequence, which was the non-linear least-square-curve fitting process, was repeated to reduce the square error to a stationary value which was expected for a noise level of the observed data. After the error figure converged to a stationary value, the integrated absorptance W,

$$W = \int A(\sigma)\, d\sigma, \tag{7}$$

was calculated for each line contained in the group using the strength and the width thus established. The standard method of obtaining the integrated absorptance by numerically integrating the observed absorptance for each line was not applicable to our data reduction, because the data contained a considerable overlapping of the lines.

The Lorentzian profile assumption used in our data analysis was in principle improper. The H_2O pressure was taken always very low in our data measurement for reduction of the line overlapping to a minimum level. The expected collision width was much smaller than the Doppler width under such a condition. We adopted the Lorentzian absorption because of the following reason. For weak lines a question of the line width did not matter because the integrated absorptance W and the strength held a linear relationship independent of the width. For strongly saturated lines, the observable absorptance contour was the wing section which was Lorentzian. The central peak region of such lines was completely saturated. The integrated absorptance W was controlled by the wing section and thus by the Lorentzian profile. The line profile in the center peak region produced a very small effect in determination of the integrated absorptance. Thus the Lorentzian profile assumption was a practical choice for extraction of the integrated absorptance even though it was theoretically improper. Once the integrated absorptance was determined, it was used to derive the

final strength value. For the Lorentzian line which was strongly saturated at the center, a strong interdependence existing between the strength S and the width α made their separate determination very impractical. With the integrated absorptance and the absorptance contour fixed, a quantity $\sqrt{S\alpha}$ was the only meaningful parameter which could be determined for such a line, even when a noise level in the data was exceptionally small. We adopted the theoretically accepted value for α^2 in derivation of the strength from the integrated absorptance. The width was extrapolated at 800°K from the value calculated for room temperature using a simple impact theory assuming

$$\alpha(T) = \alpha(T_0)\left(\frac{T_0}{T}\right)^{n/2} .$$

Results and Discussion

The results obtained in the present study are summarized in Table I. The data listed in the table are the line frequency in cm^{-1}, the strength S in $(cm^{-1}/molecule\ cm^{-2})$ at 800°K, the observed integrated absorptance for an observation condition p_{H_2O} = [illegible] mm, T = 800°K and ℓ = 350 cm, the lower state energy in cm^{-1}, the quantum identification (J', Ka', Kc'), (J", Ka", Kc"), (v'$_1$, v'$_2$, v'$_3$) and (v"$_1$, v"$_2$, v"$_3$), the line identification code, the intensity code, the [illegible] between the observed frequency and the [illegible] AFGL line listing. The data are arranged [illegible] line position. Figure 1 shows four spectral data, the raw spectrum observed at the H_2O column density of 3.17 x 10^{20} molecules over 350 cm absorption path at 800°K, the absorptance spectrum derived for the analysis, the synthetic spectrum calculated using the parameters determined in the analysis, and the spectrum synthesized using the parameters given in the latest AFGL line listing. The data listed in Table I contain those lines

newly identified in the present study, which are the high J lines of the (ν_2-0) and the ($2\nu_2$-ν_2) transitions. We were able to follow the ν_2 transitions up to the $(24_{1,24}-23_{0,23})-(24_{0,24}-23_{1,23})$ doublet, and the ($2\nu_2$-ν_2) transition up to the $(20_{1,20}-19_{0,19})-(20_{0,20}-19_{1,19})$ doublet. The highest excitation energy observed at 800°K in our data exceeded 5000 cm^{-1}. Table II summarizes those lines which were either newly assigned or quite different from the latest AFGL line listing.

One thing noticed as peculiar in the present study was that the strongly saturated lines had a central peak much narrower than that theoretically constructed. The pronounced wing absorption was found to produce no matching to a sharp central peak. The synthetic spectrum shown in the third row of Figure 1 was generated by the Lorentzian line profile which had the narrowest central peak of the other profiles, the Gaussian and the Voigt. For an example, the doublet $(11_{0,11}-10_{1,10})$ and $(11_{1,11}-10_{0,10})$ of the ν_2 band exhibited two sharp peaks, one at 1801.3260 and another at 1801.3621, clearly separated in the observed data. The synthetic spectrum, the third trace of Figure 1, failed to show a corresponding central structure. The observed data indicated that the central region was far narrower than the peak structure which could have been theoretically constructed for the observed wing region. No explanations were found to this observation.

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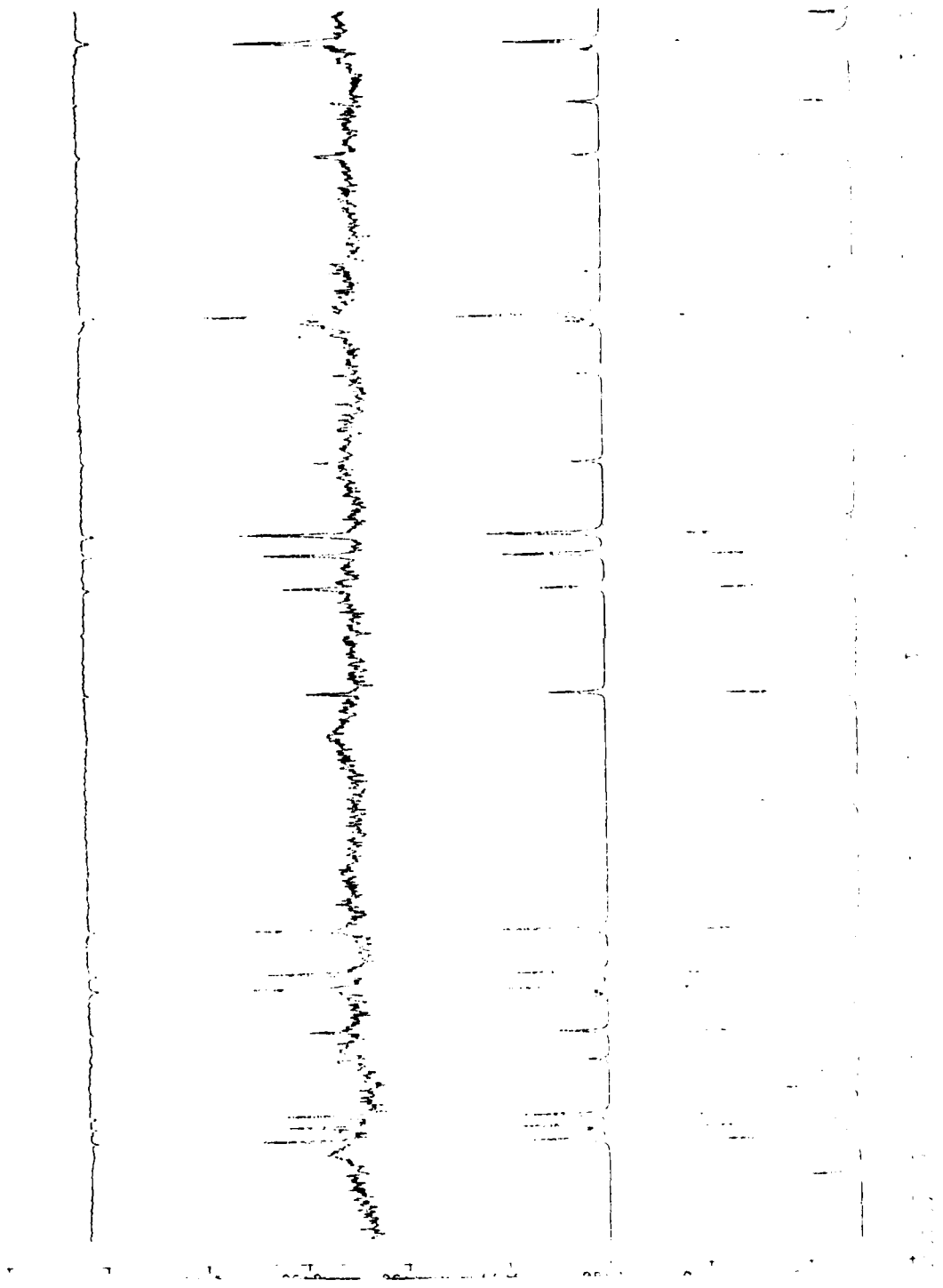
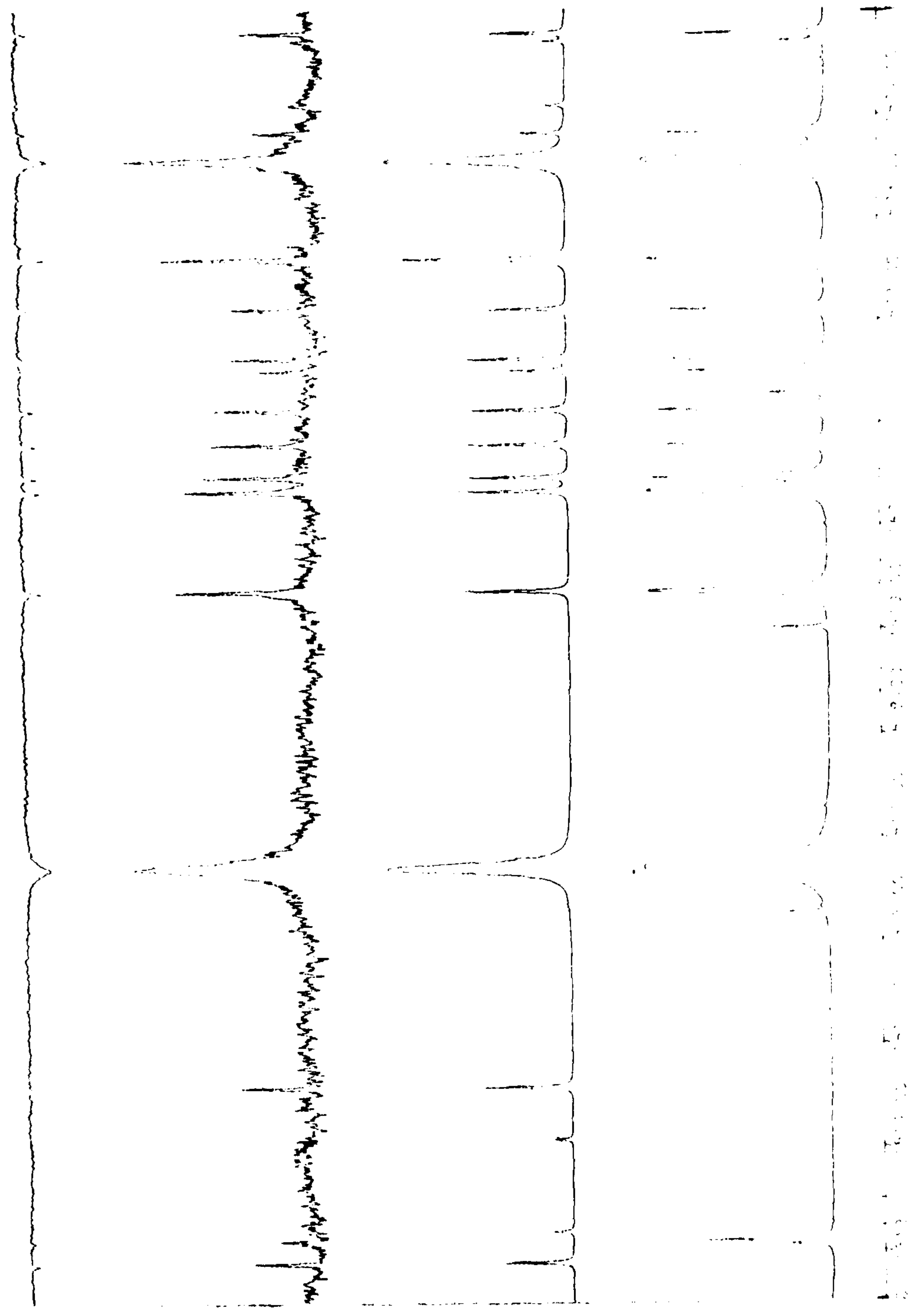
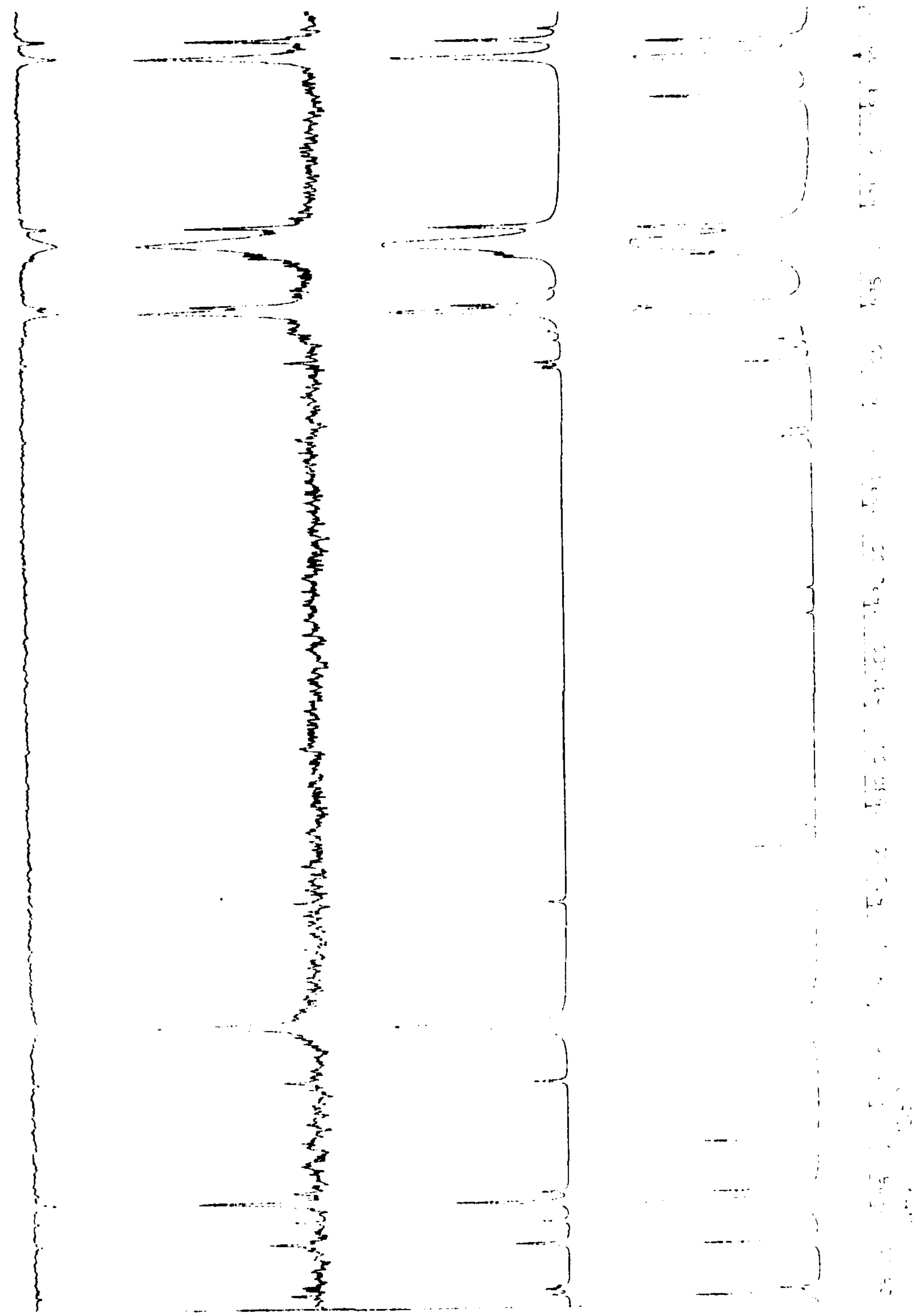
Figure 1

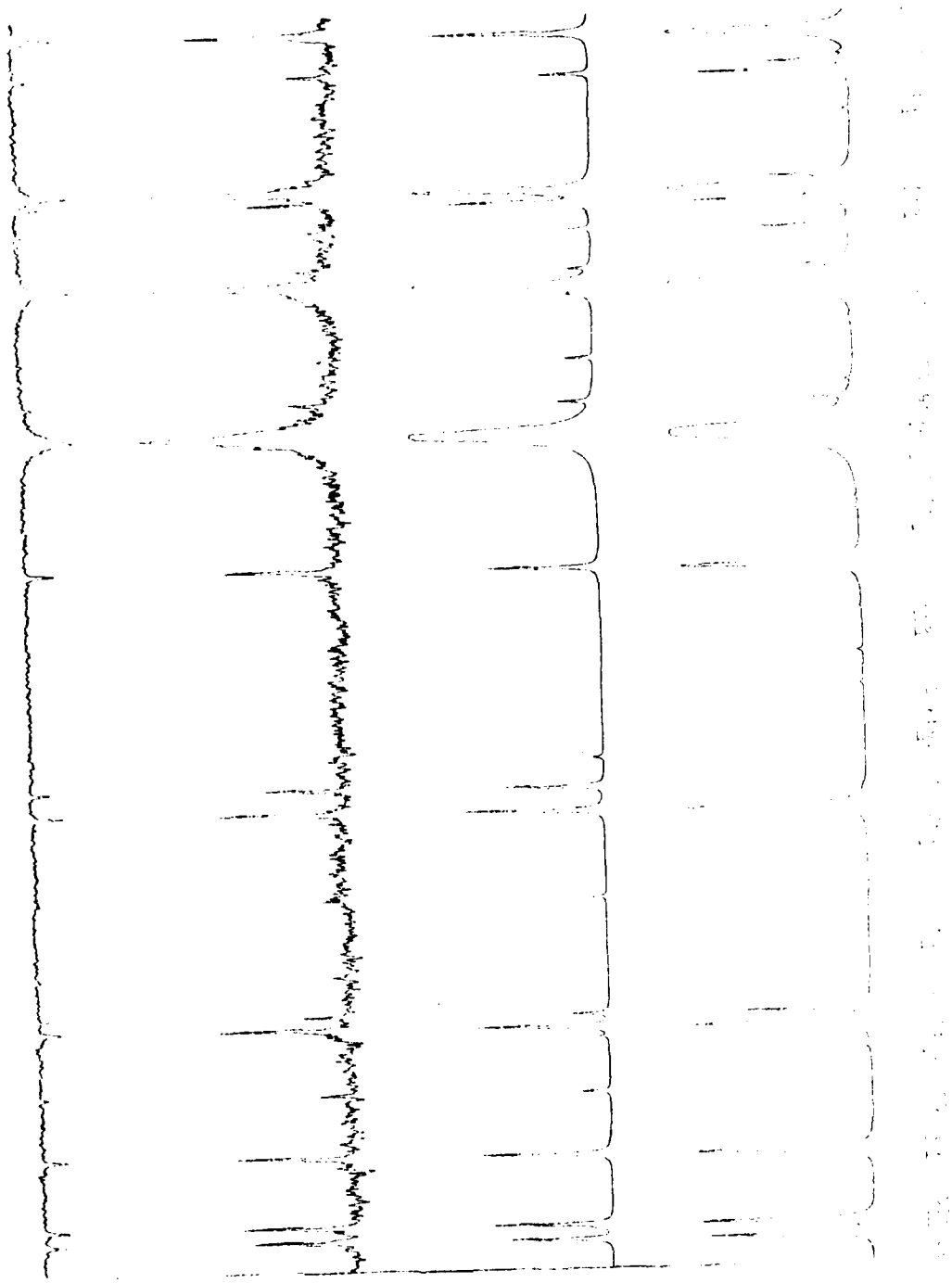
Atlas of H_2O absorption spectrum between 1600 ∿ 2000 cm^{-1} taken at the gas temperature = 800°K, the absorption path = 350 cm, the H_2O pressure = 6.0 torr (no other gases added), and the spectral resolution = 0.0060 cm^{-1}. The top trace is the raw data. The second is the absorptance data determined from the raw data. The third is the absorptance spectrum synthesized from the line parameters determined in the present work. The bottom trace is the absorptance spectrum synthesized for the same condition using the line parameters of the current AFGL listing (1980 version).

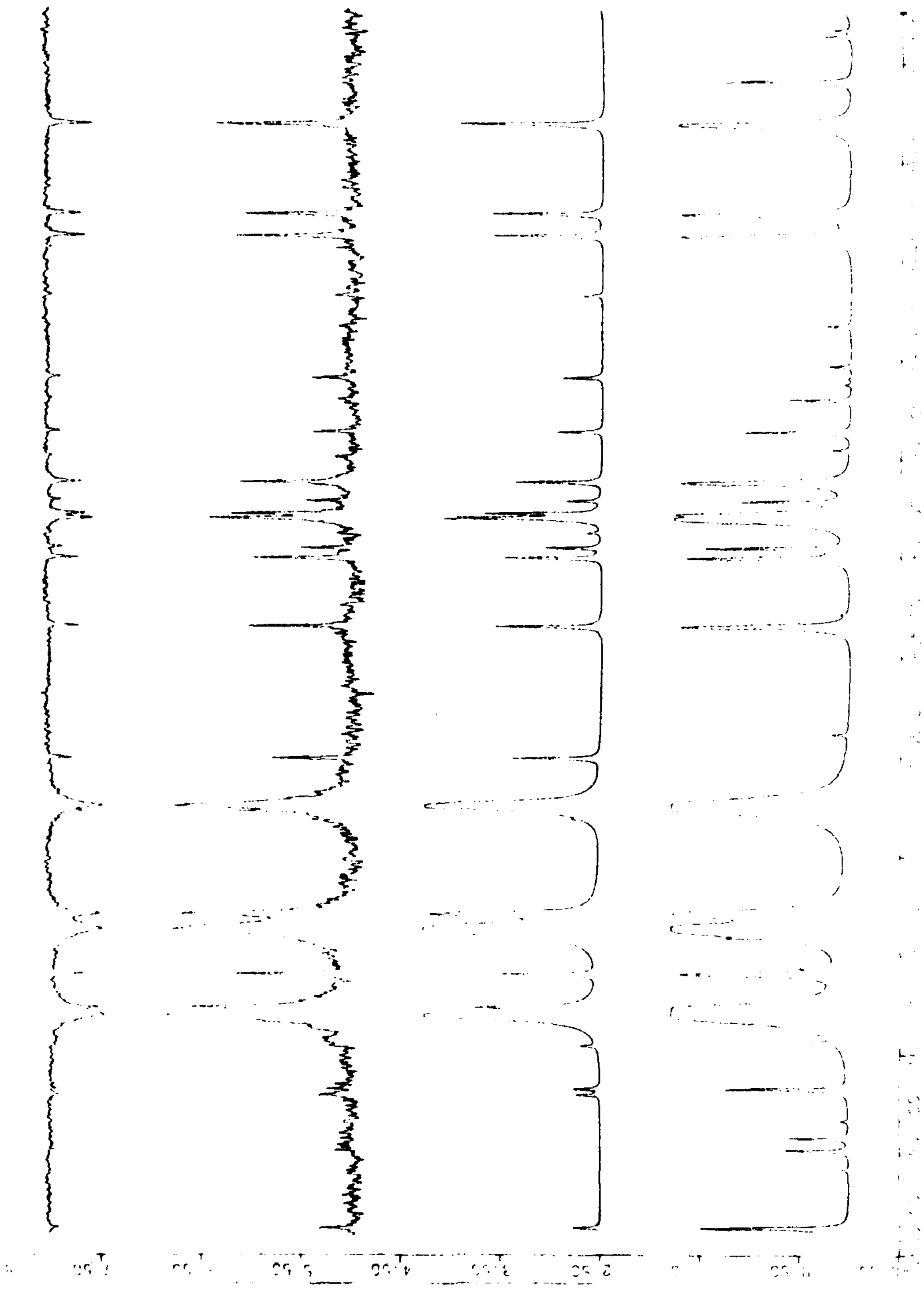
Figure 1

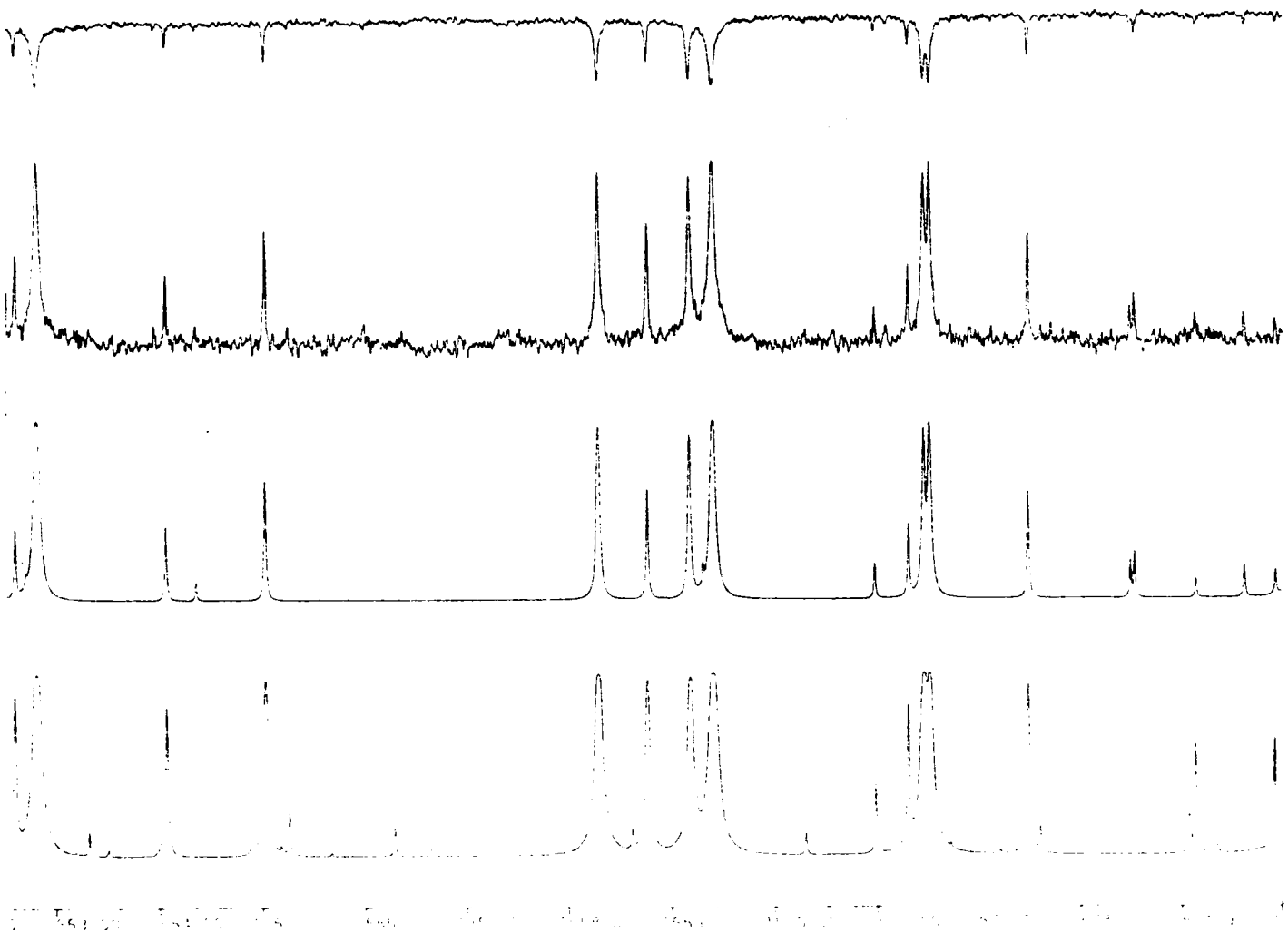


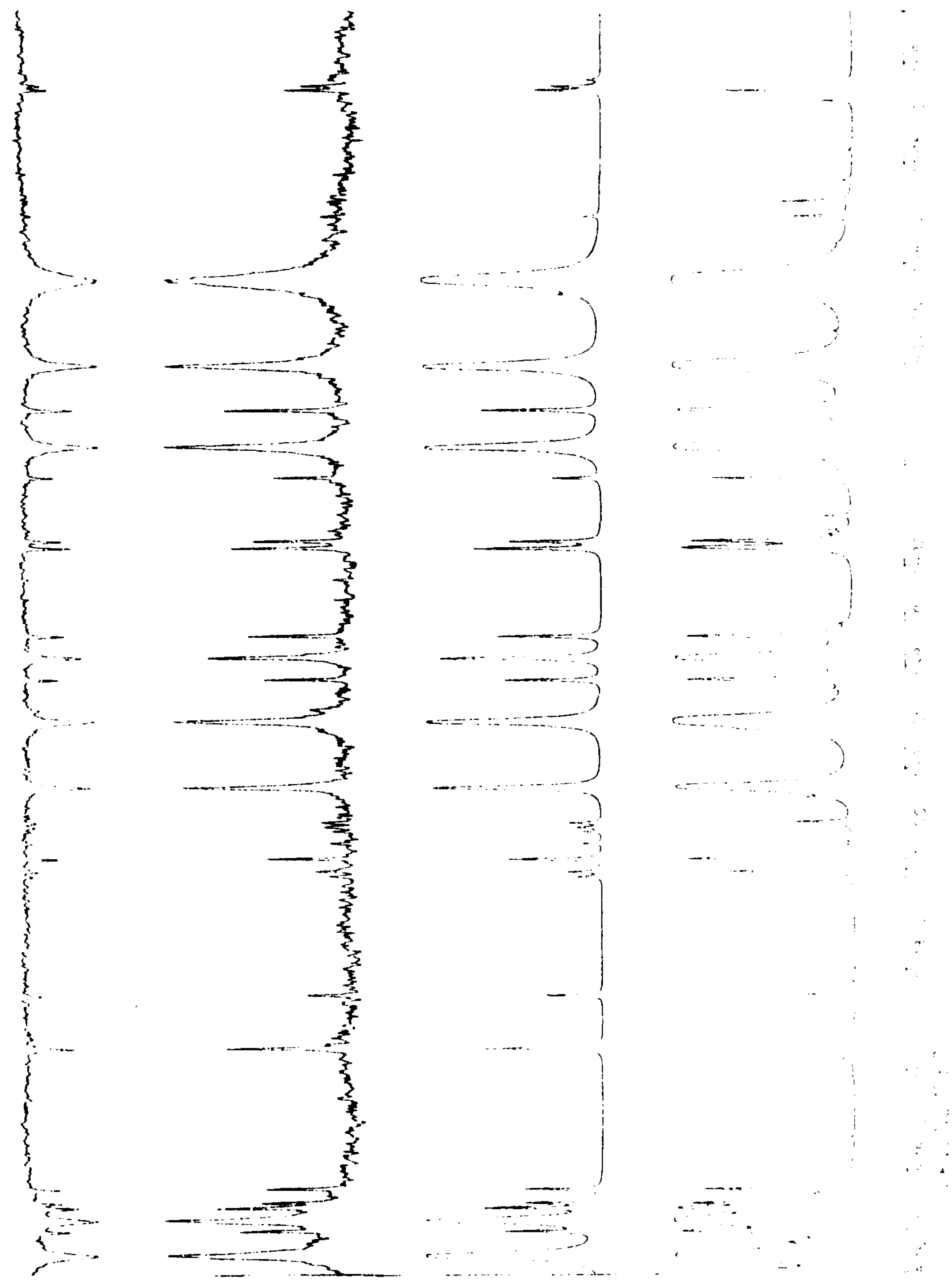


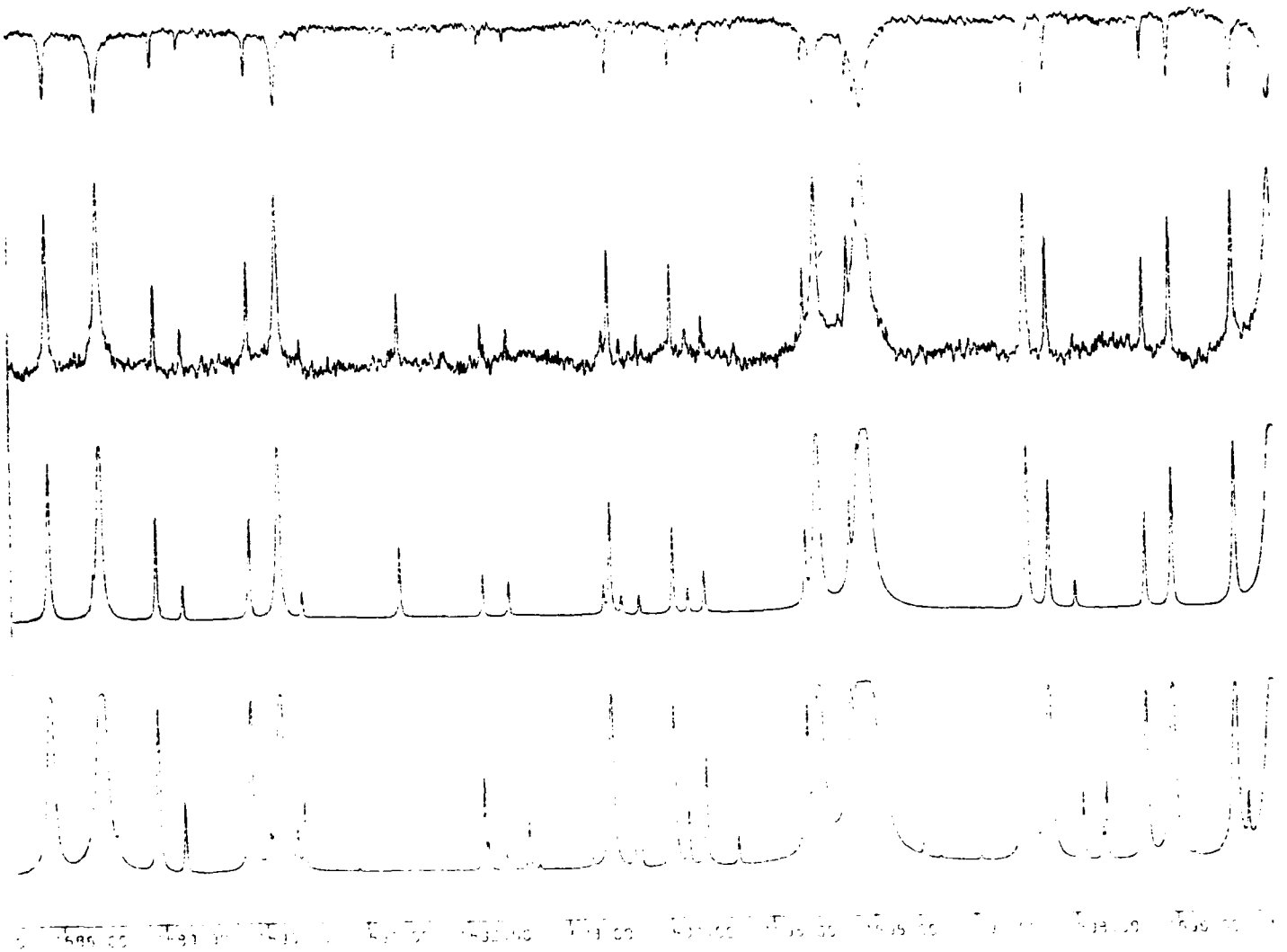


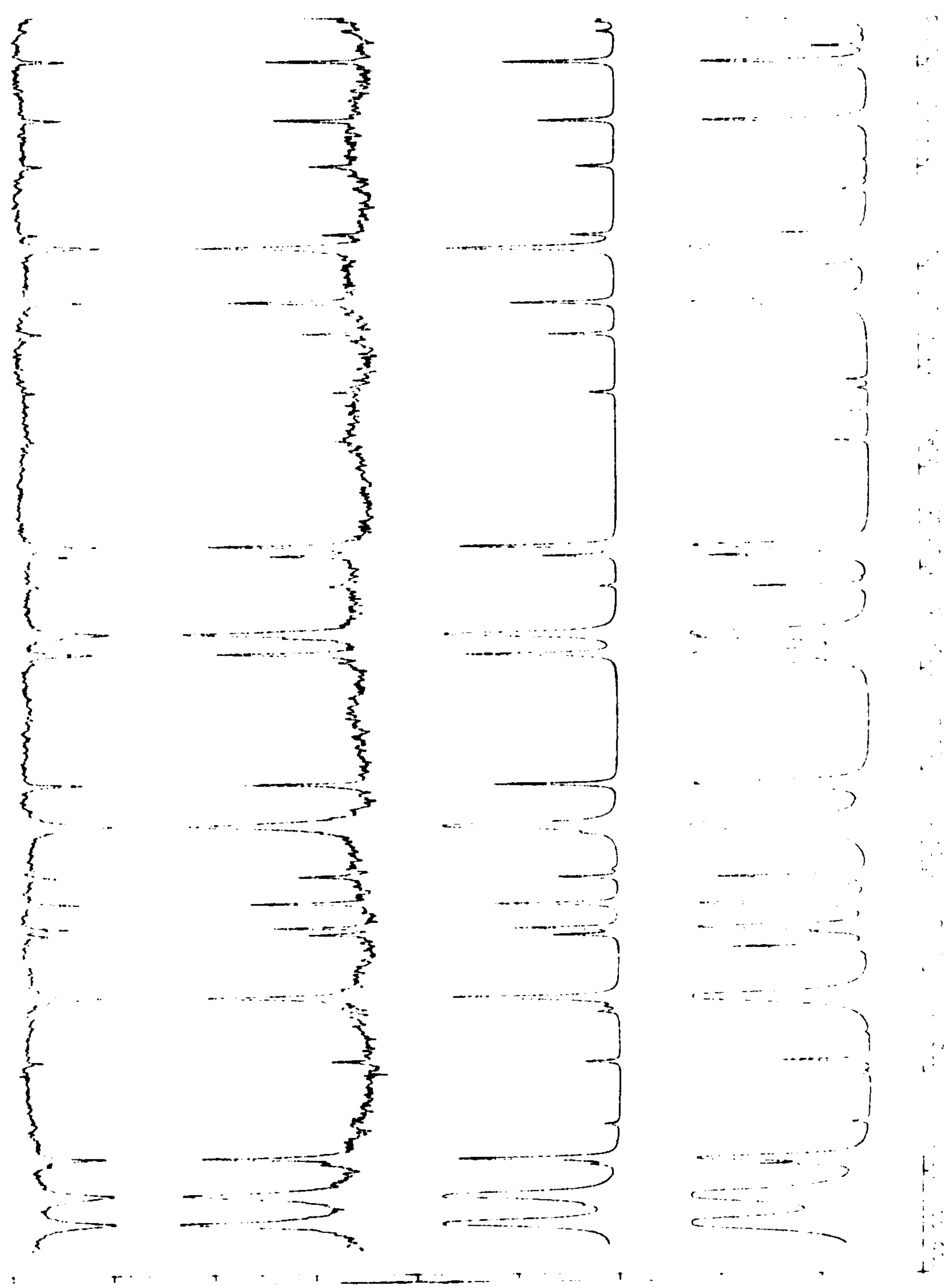


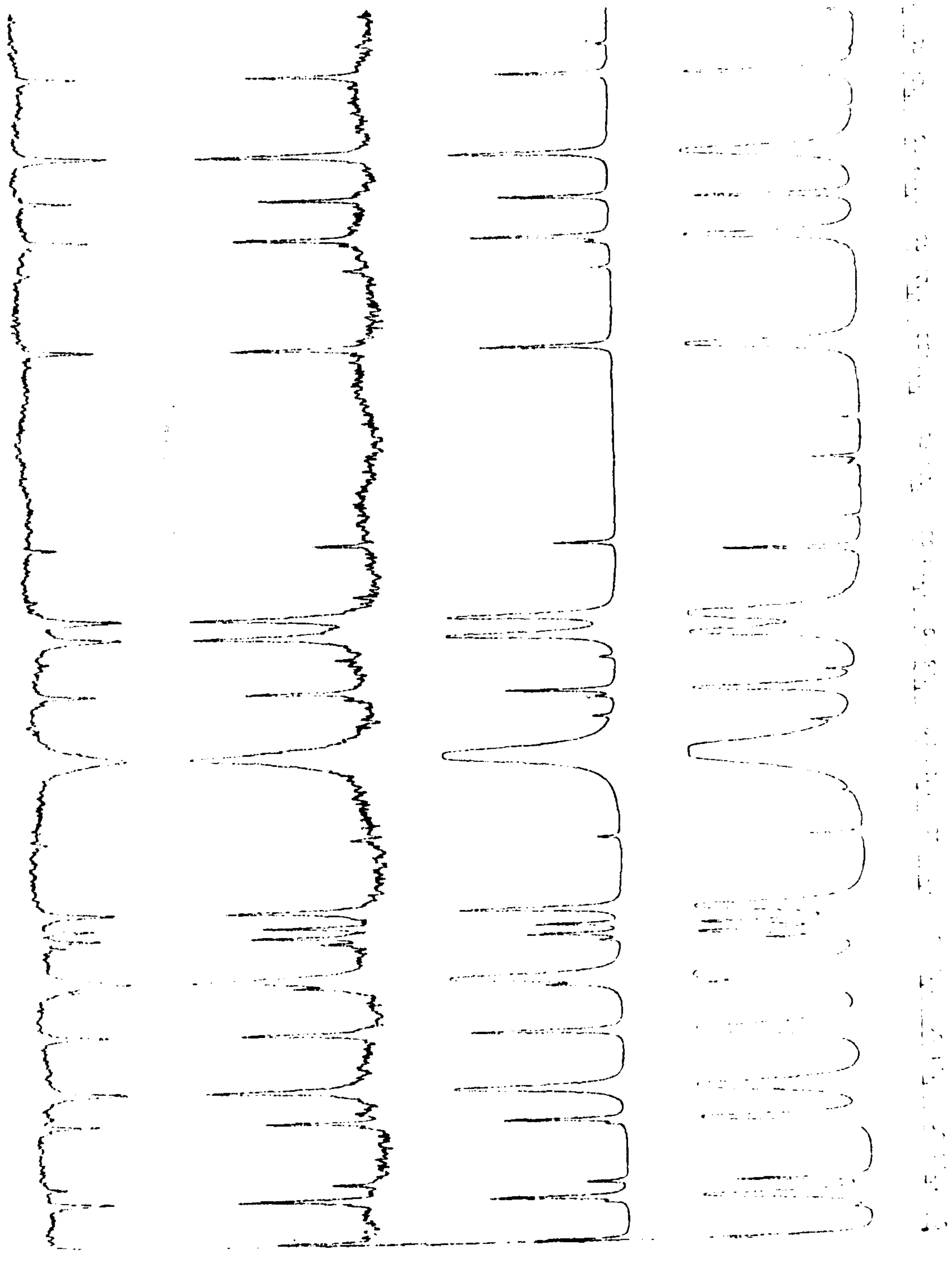


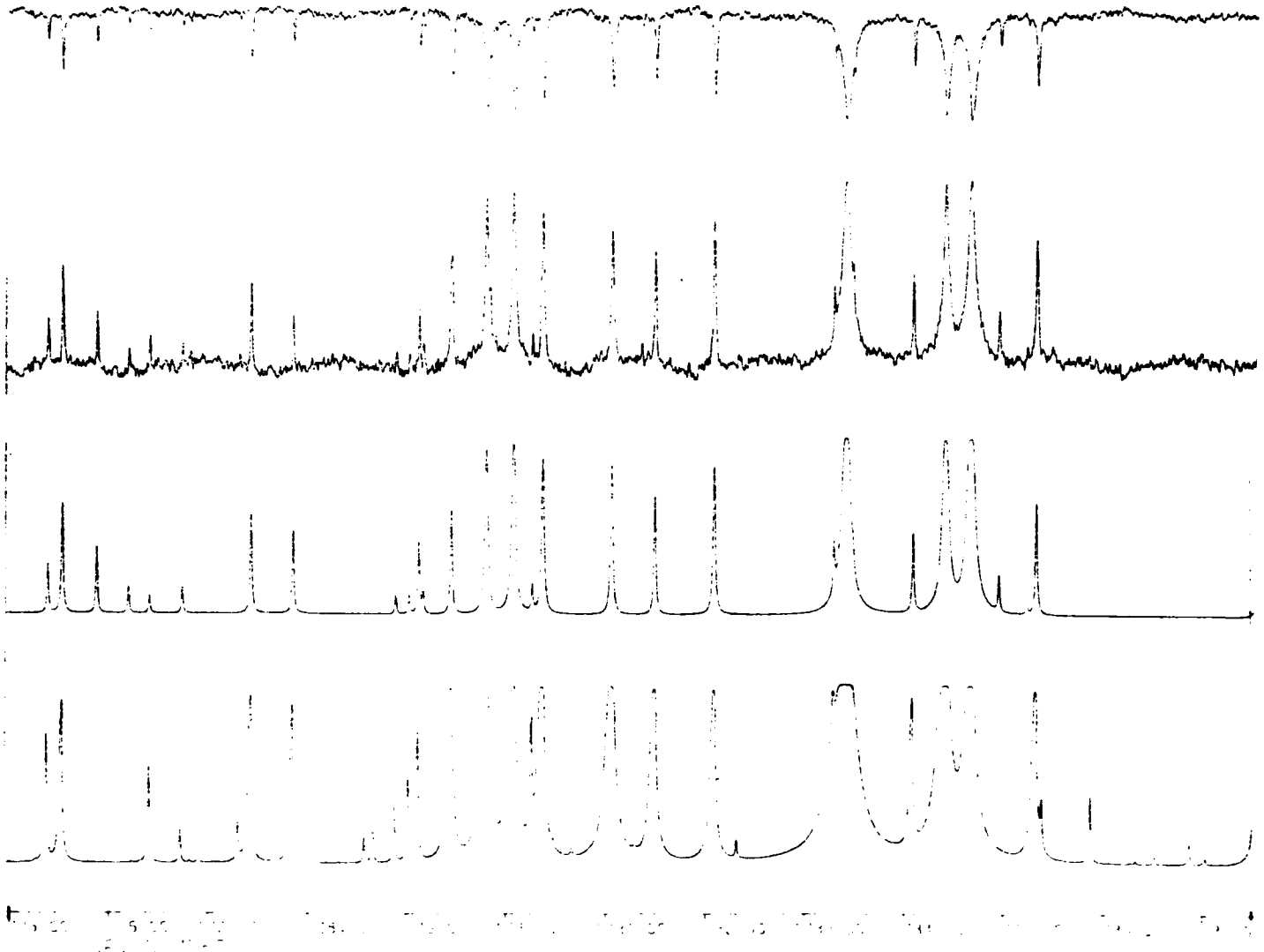


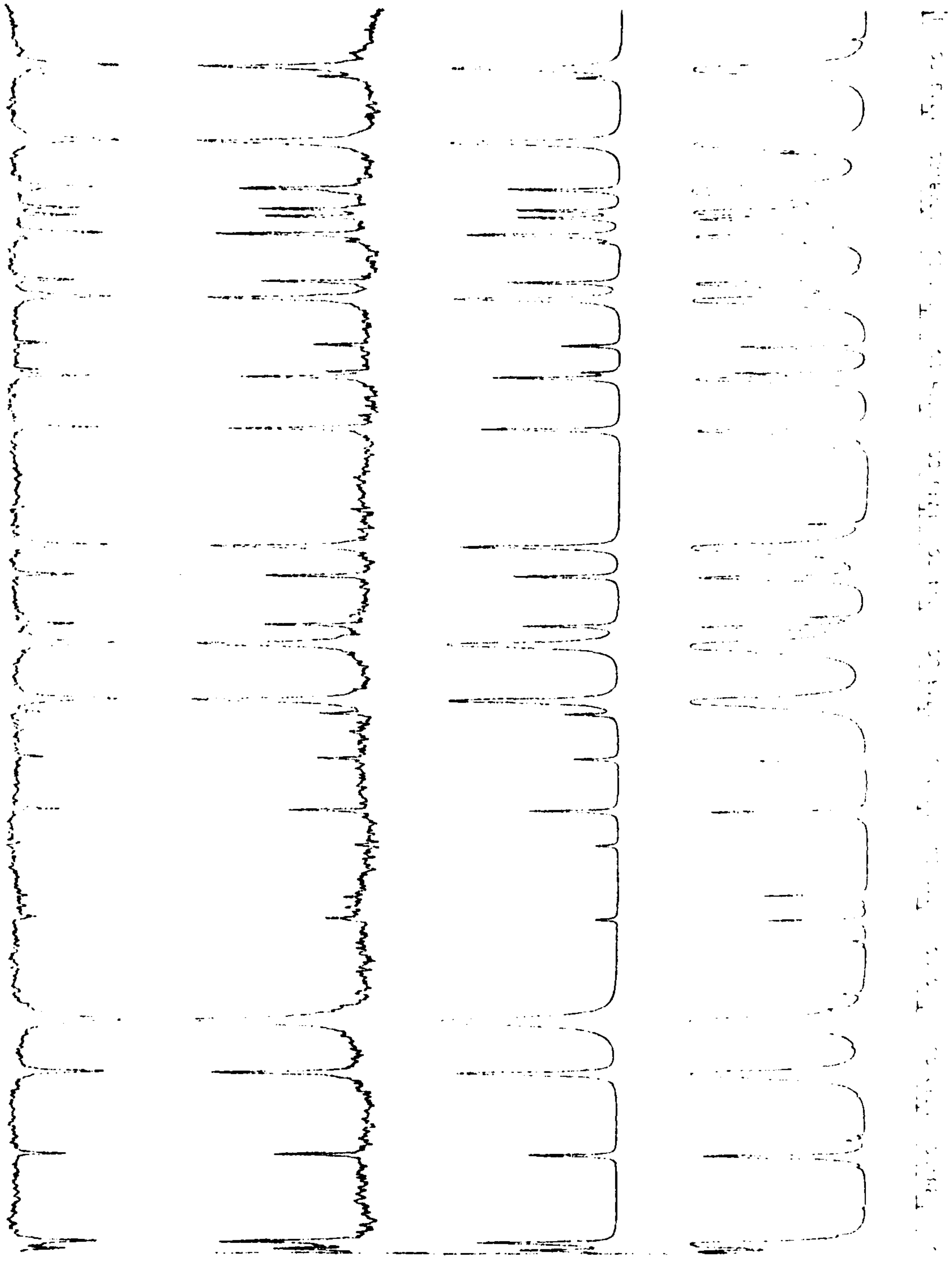


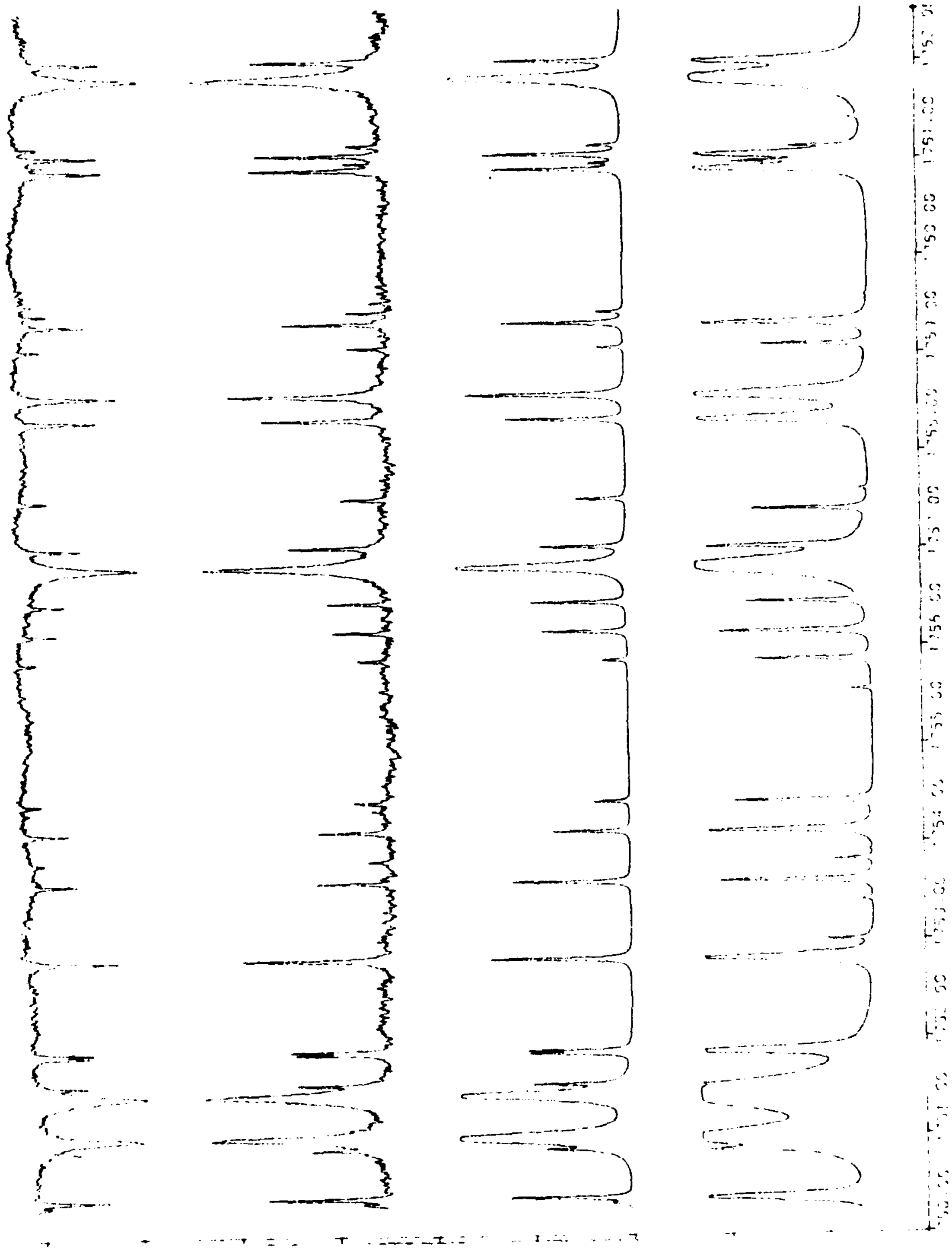


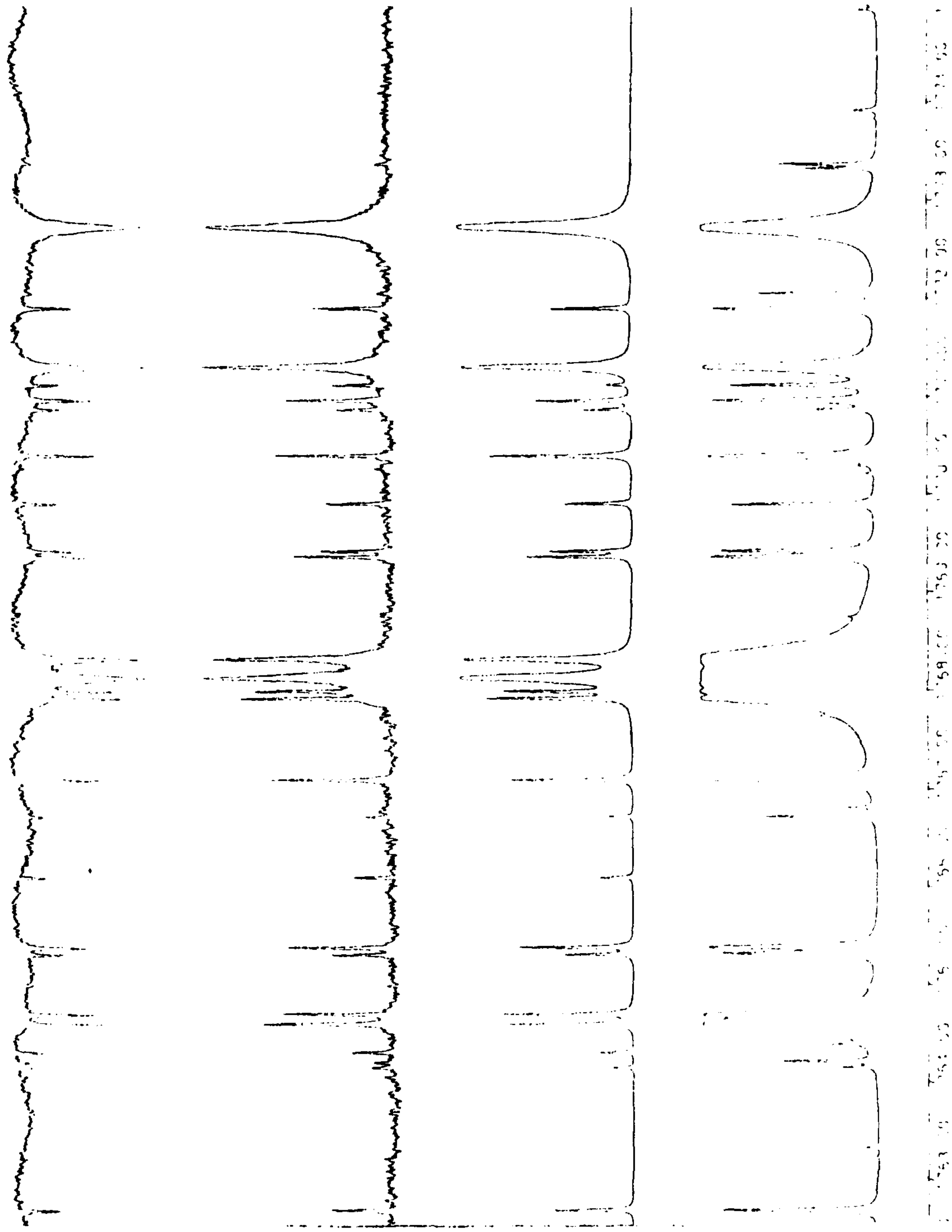


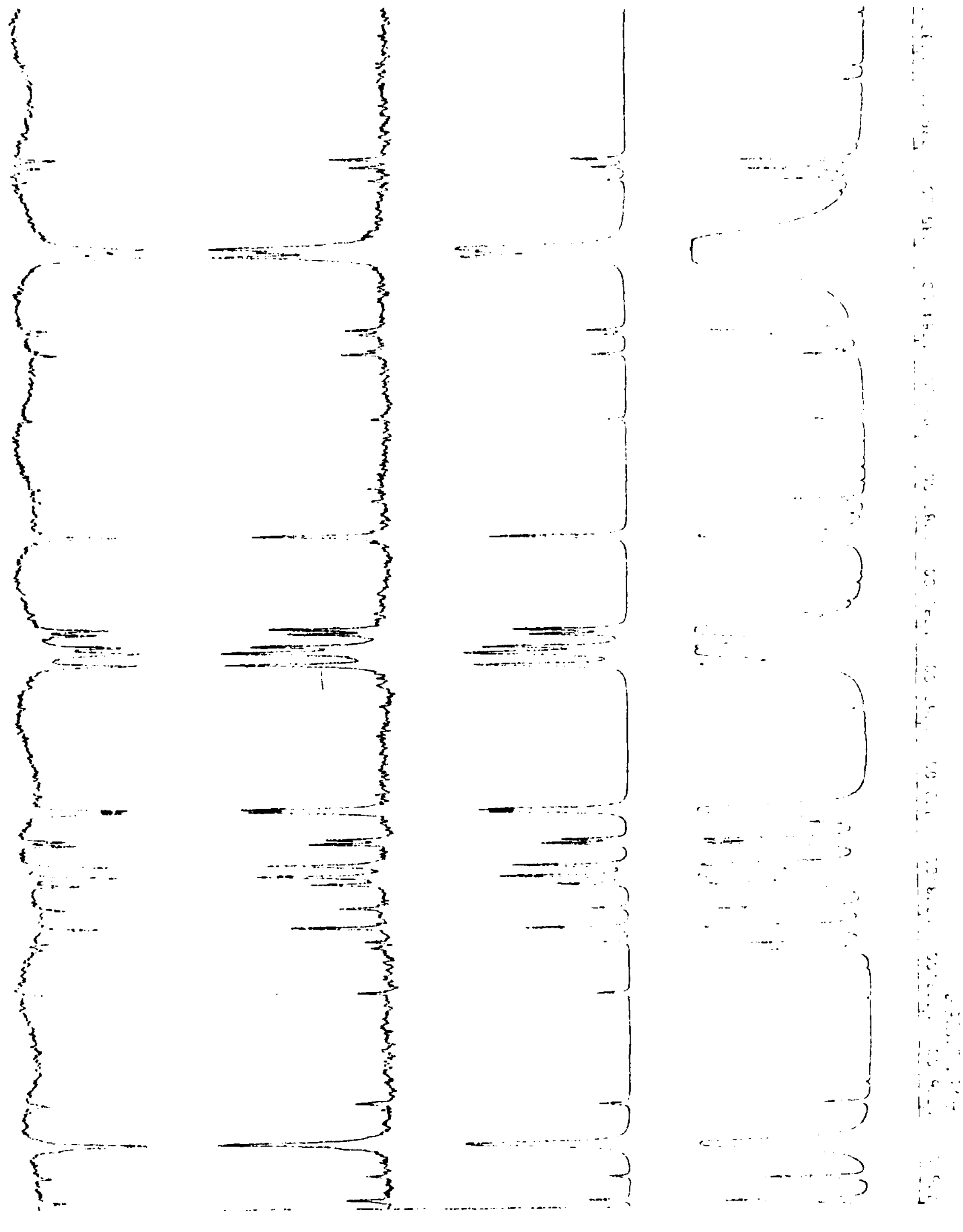


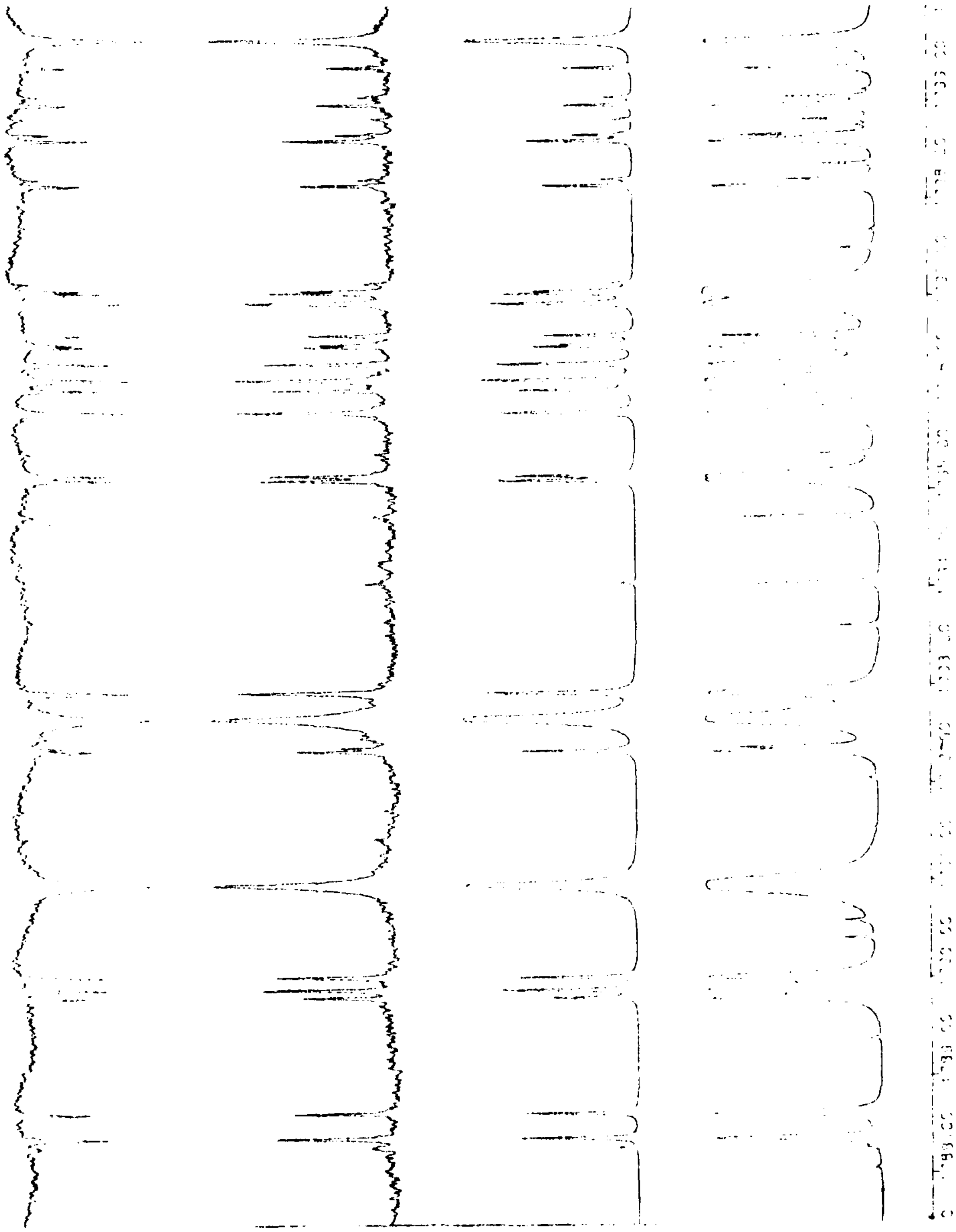


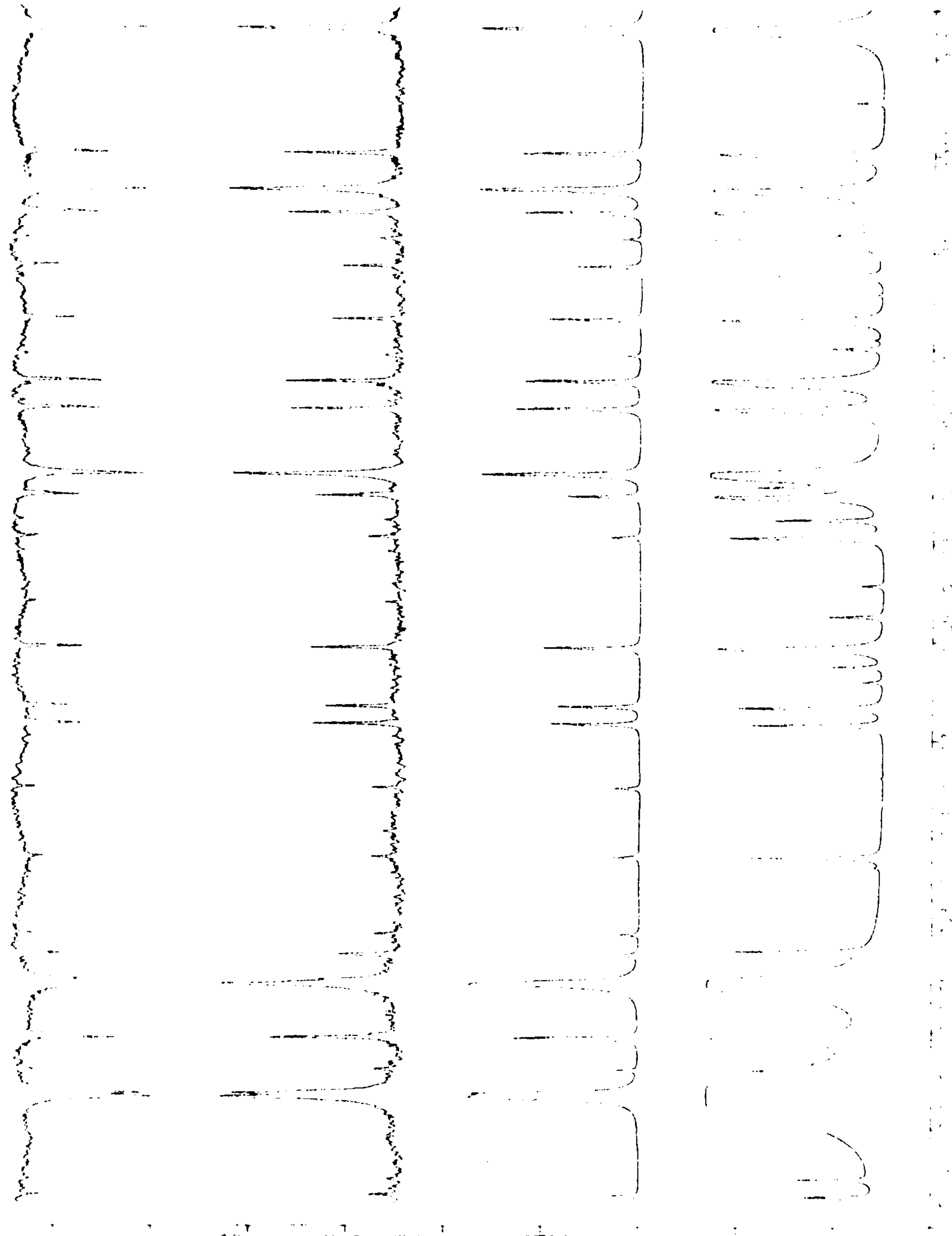


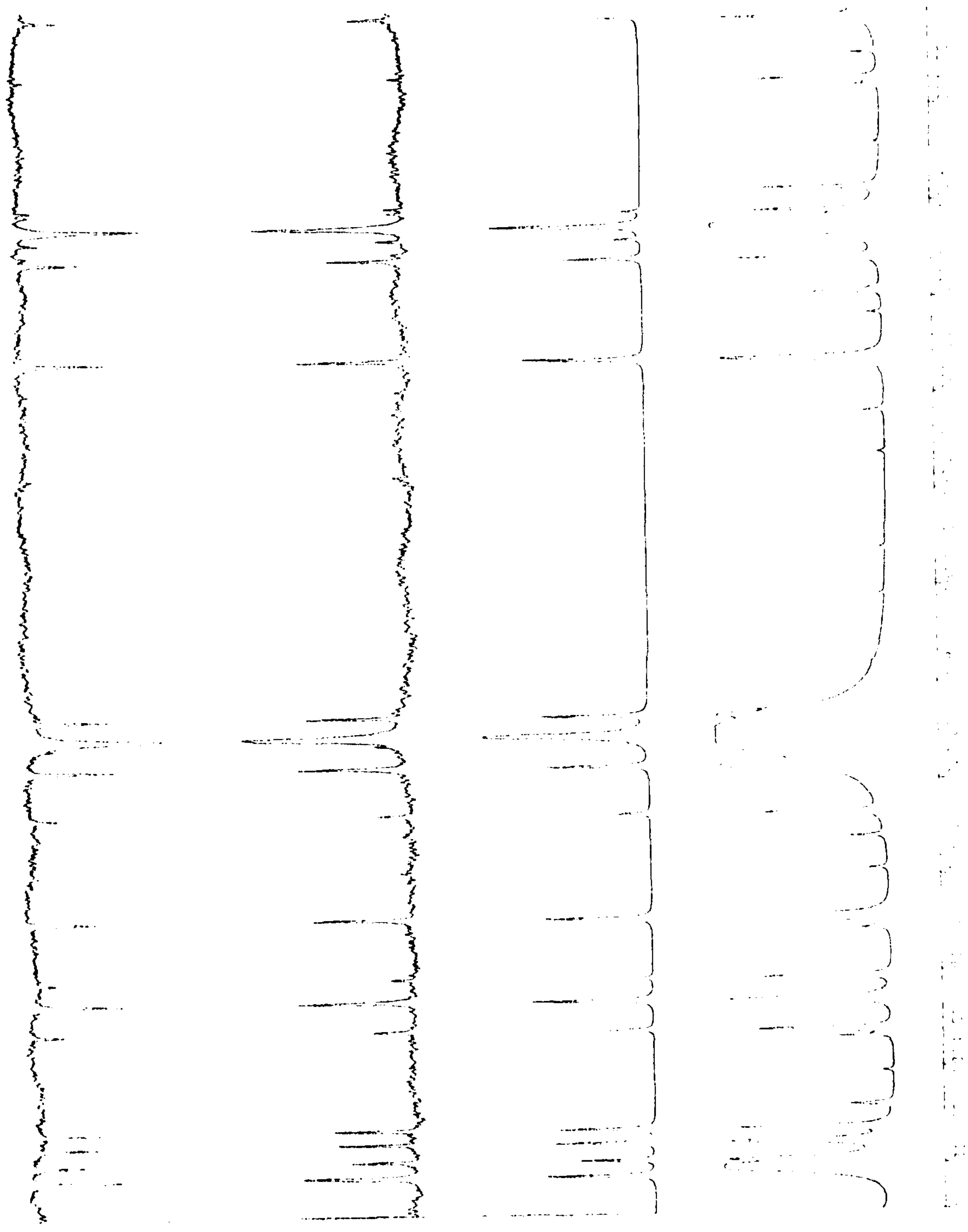


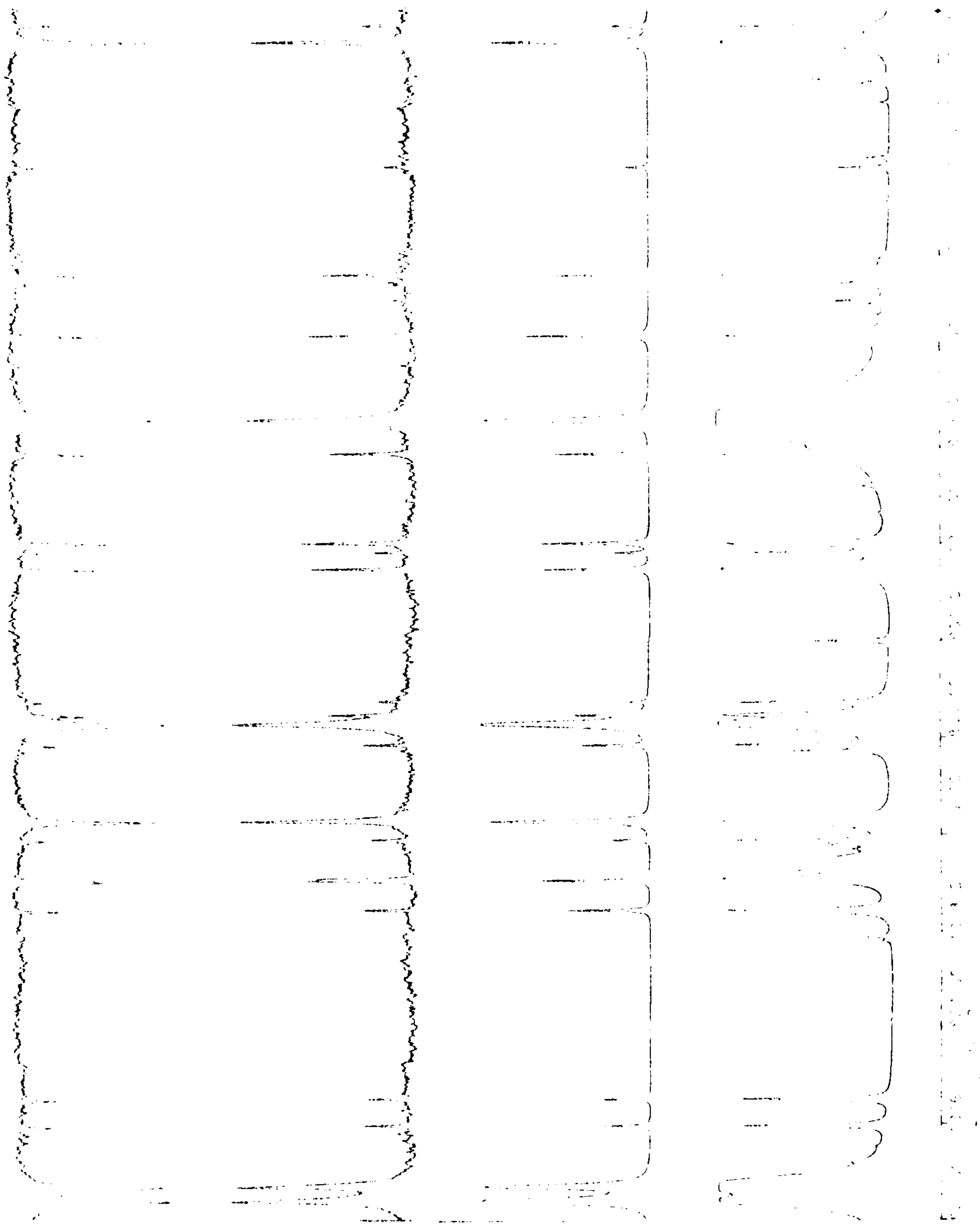


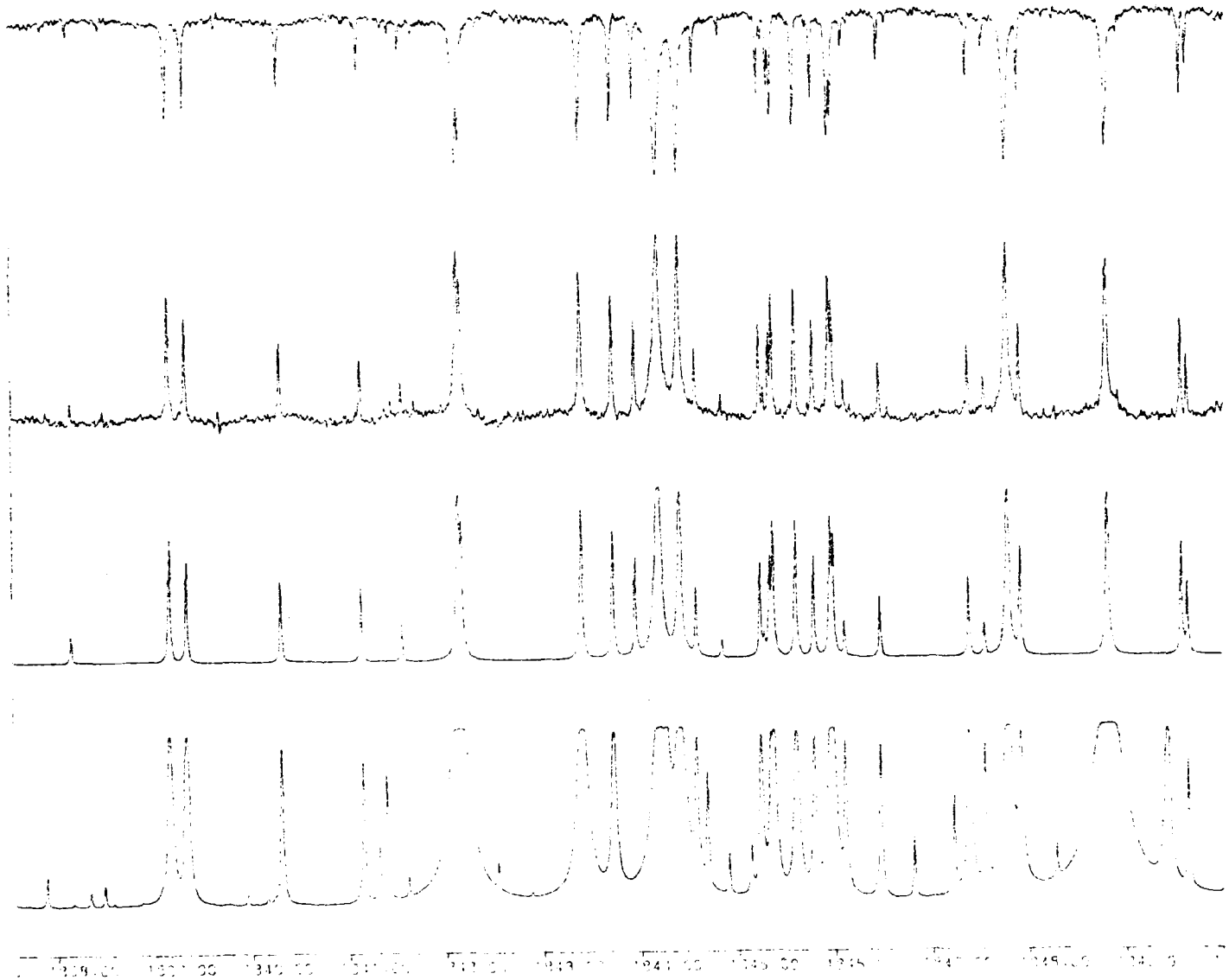


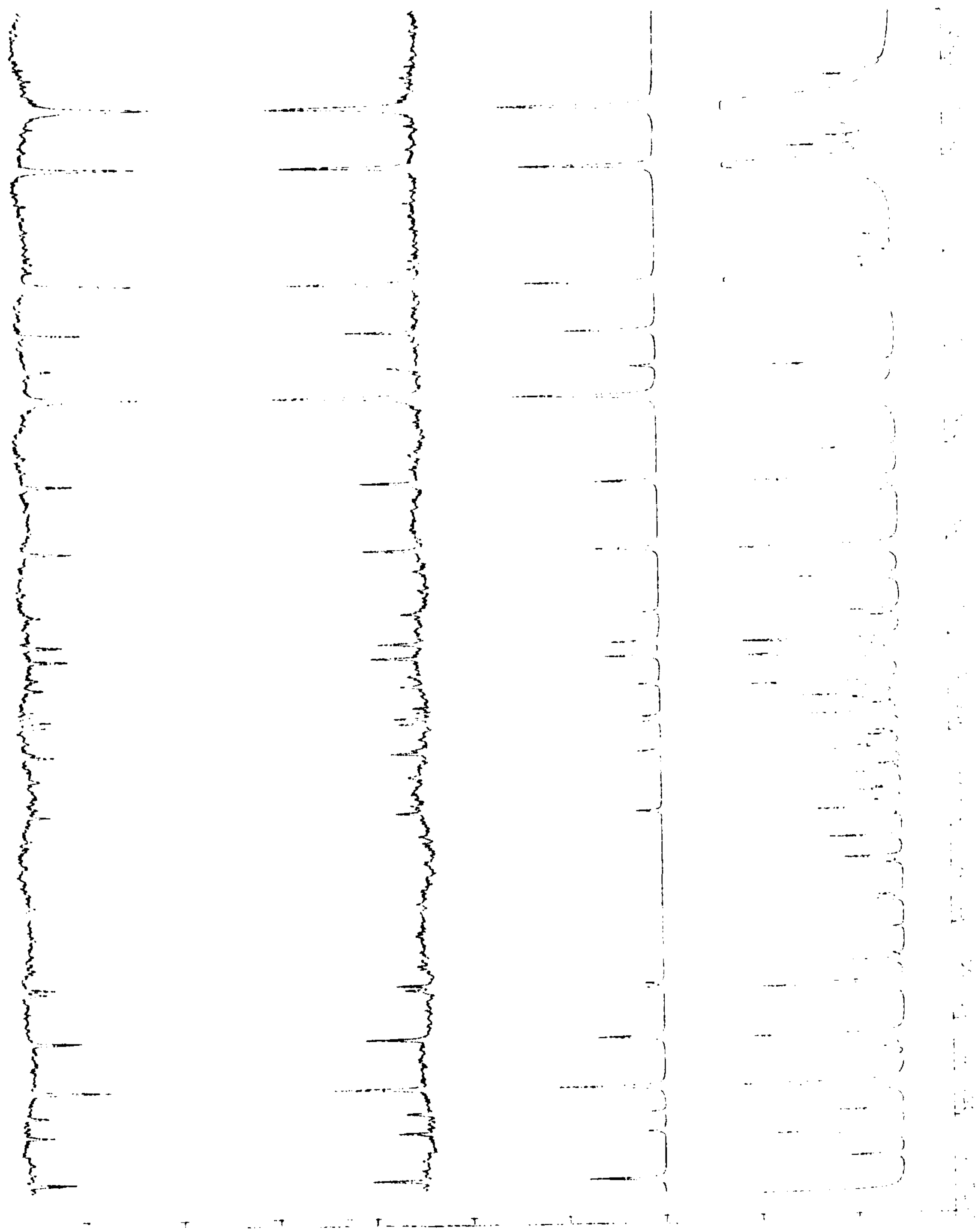


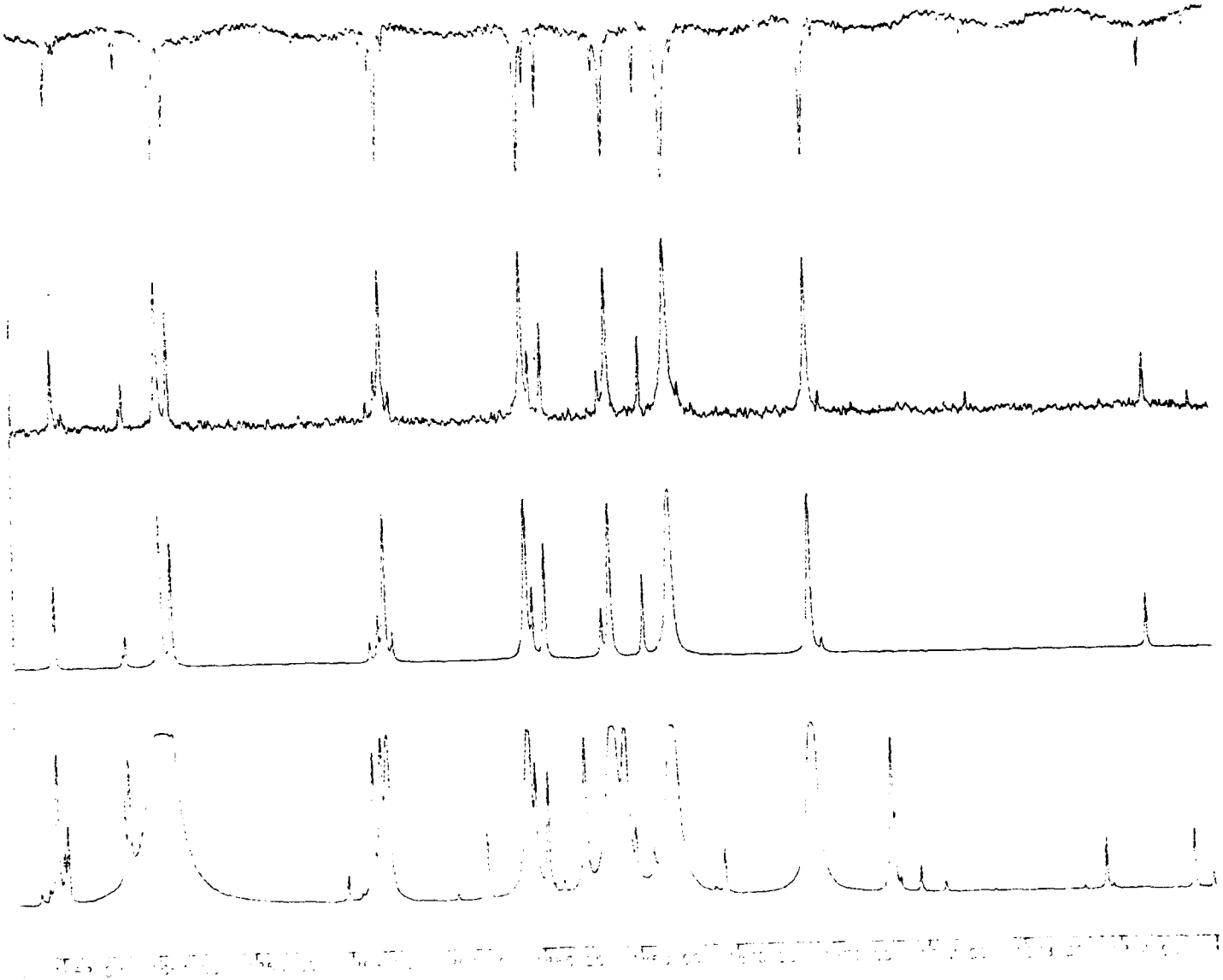


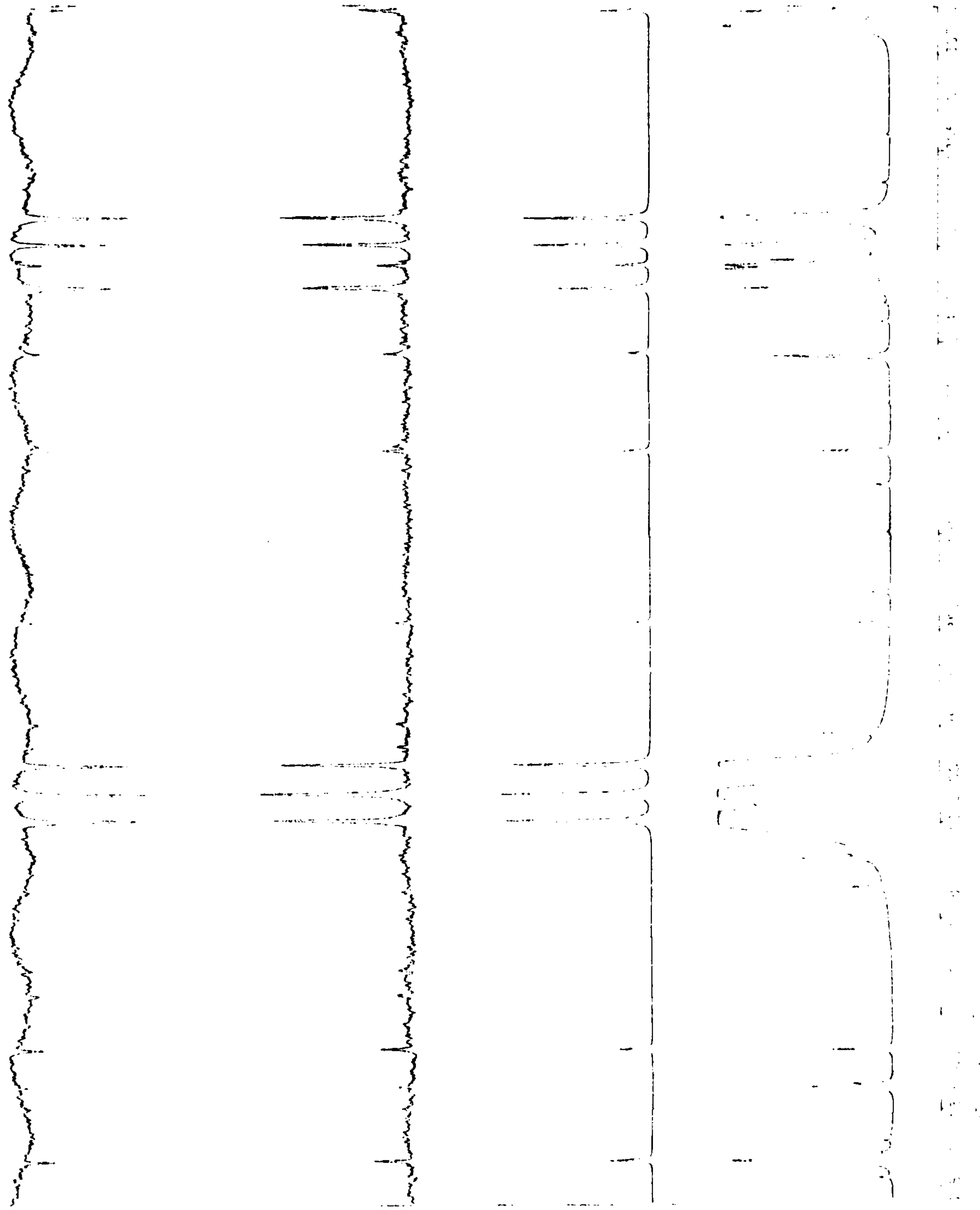


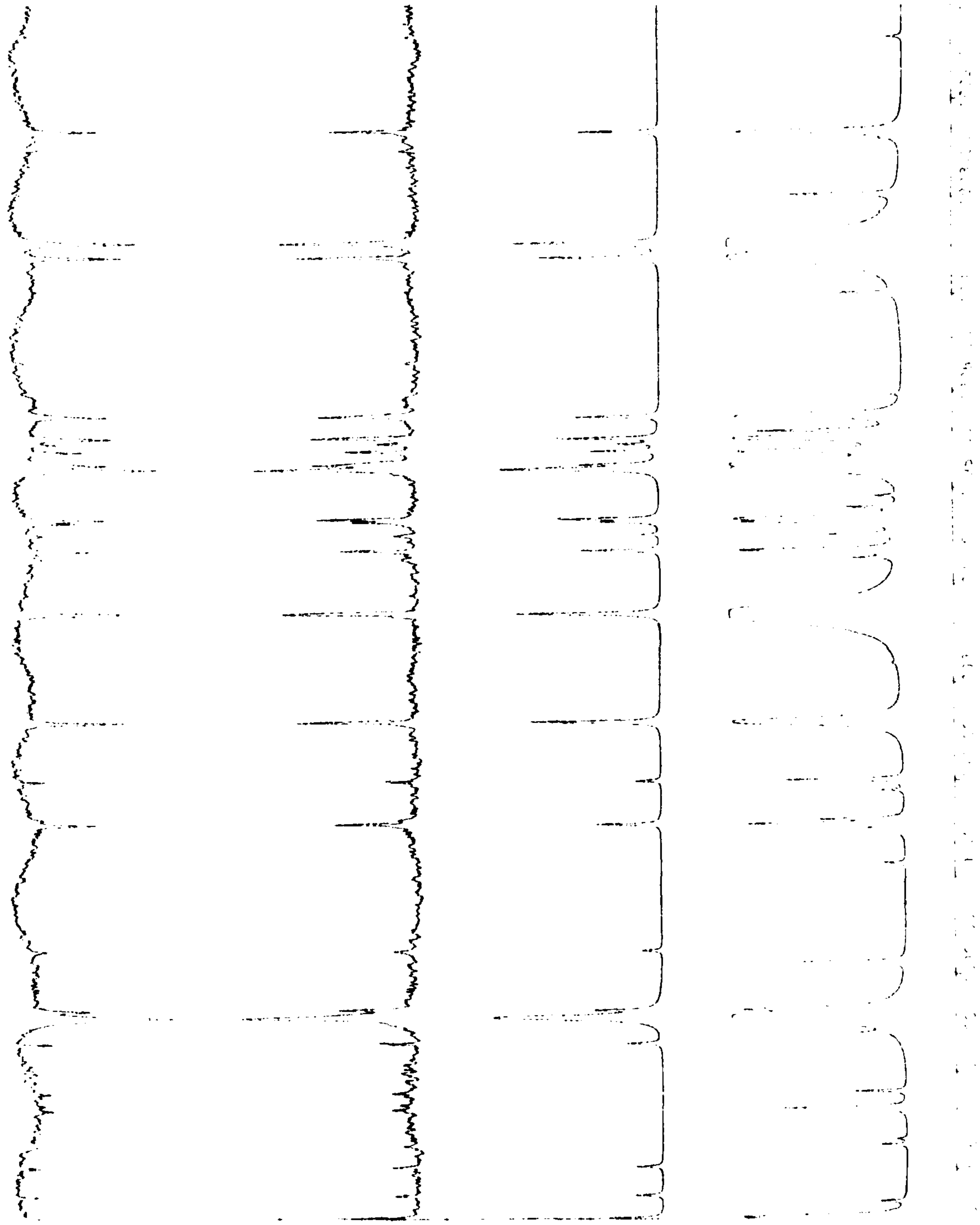


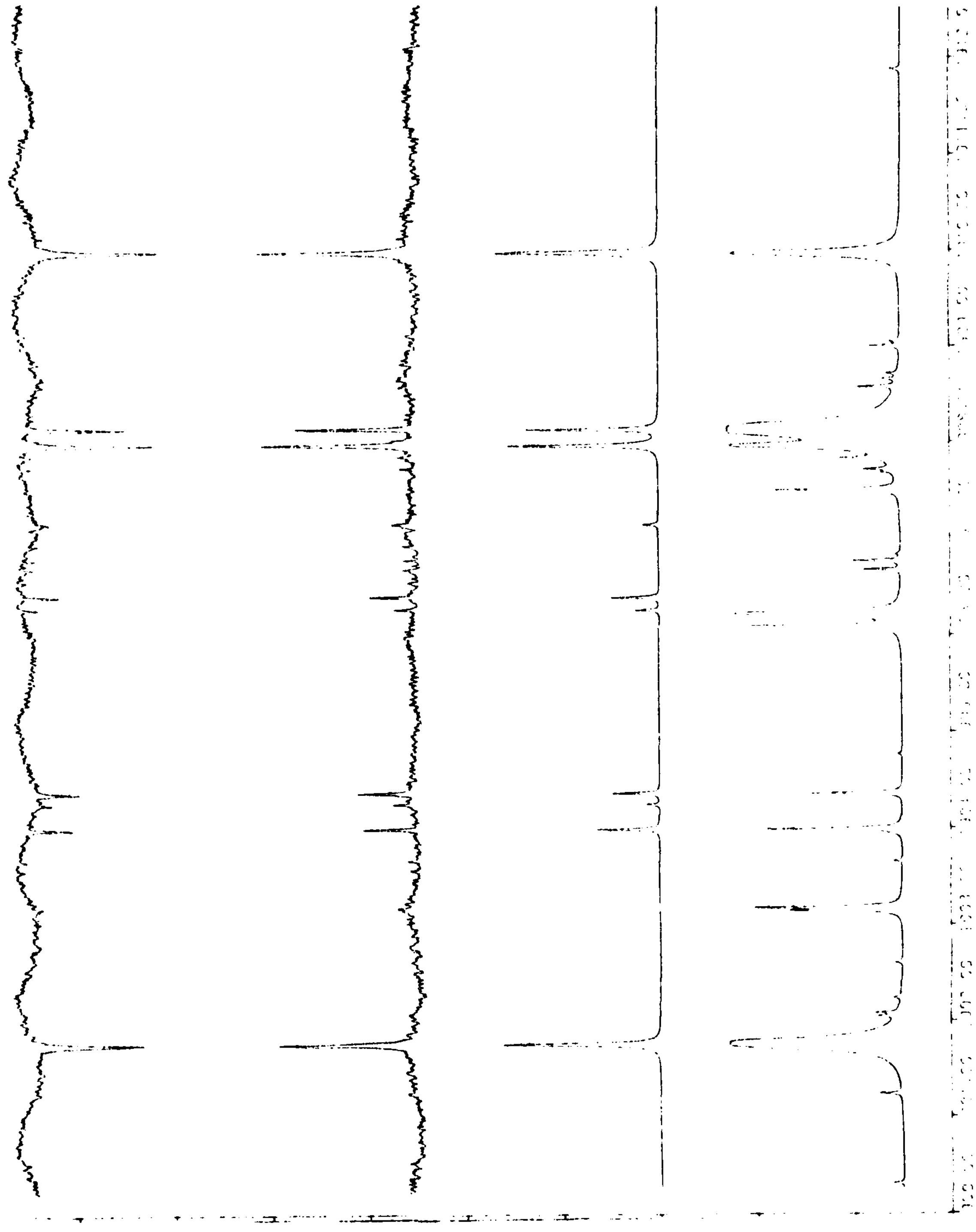


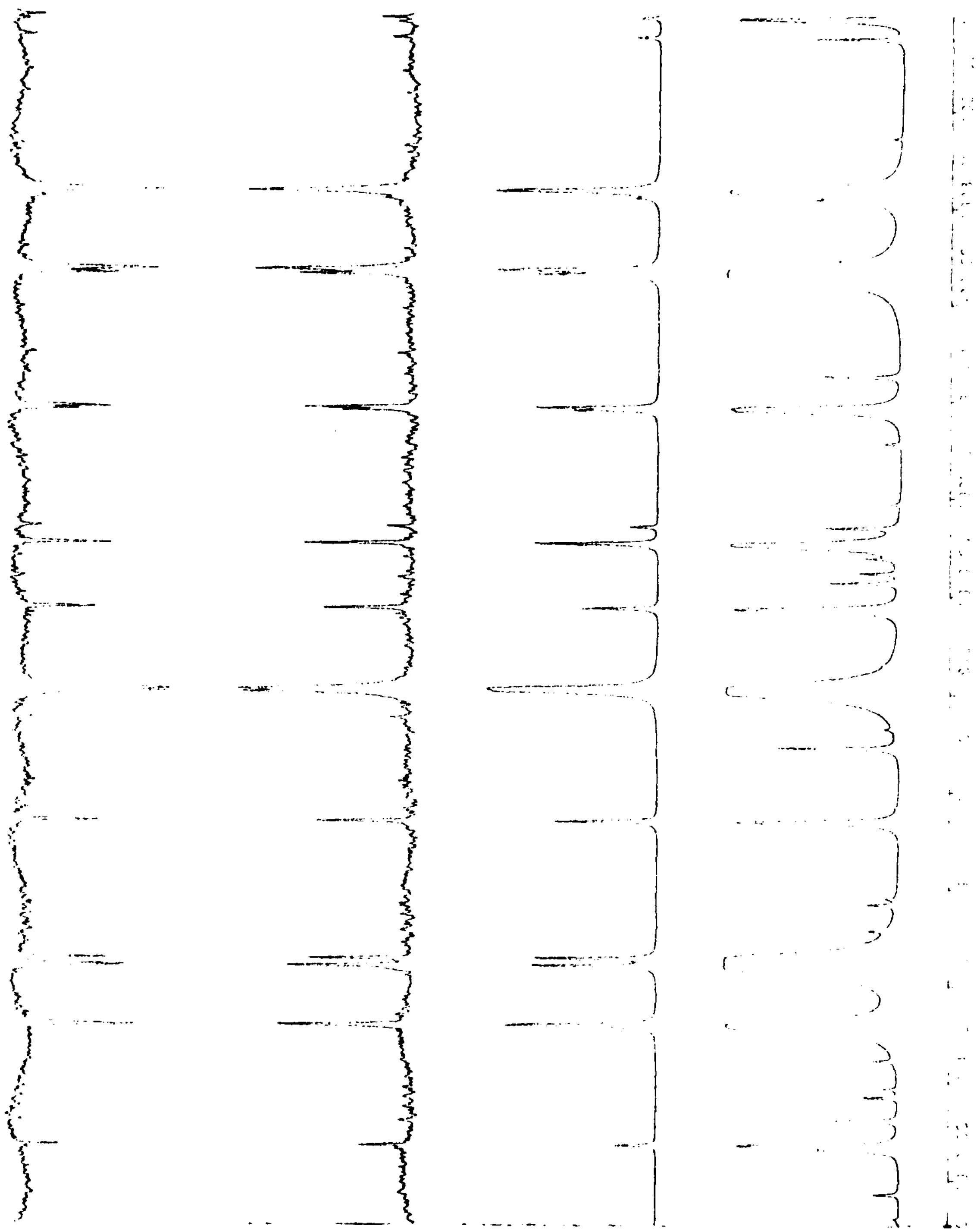


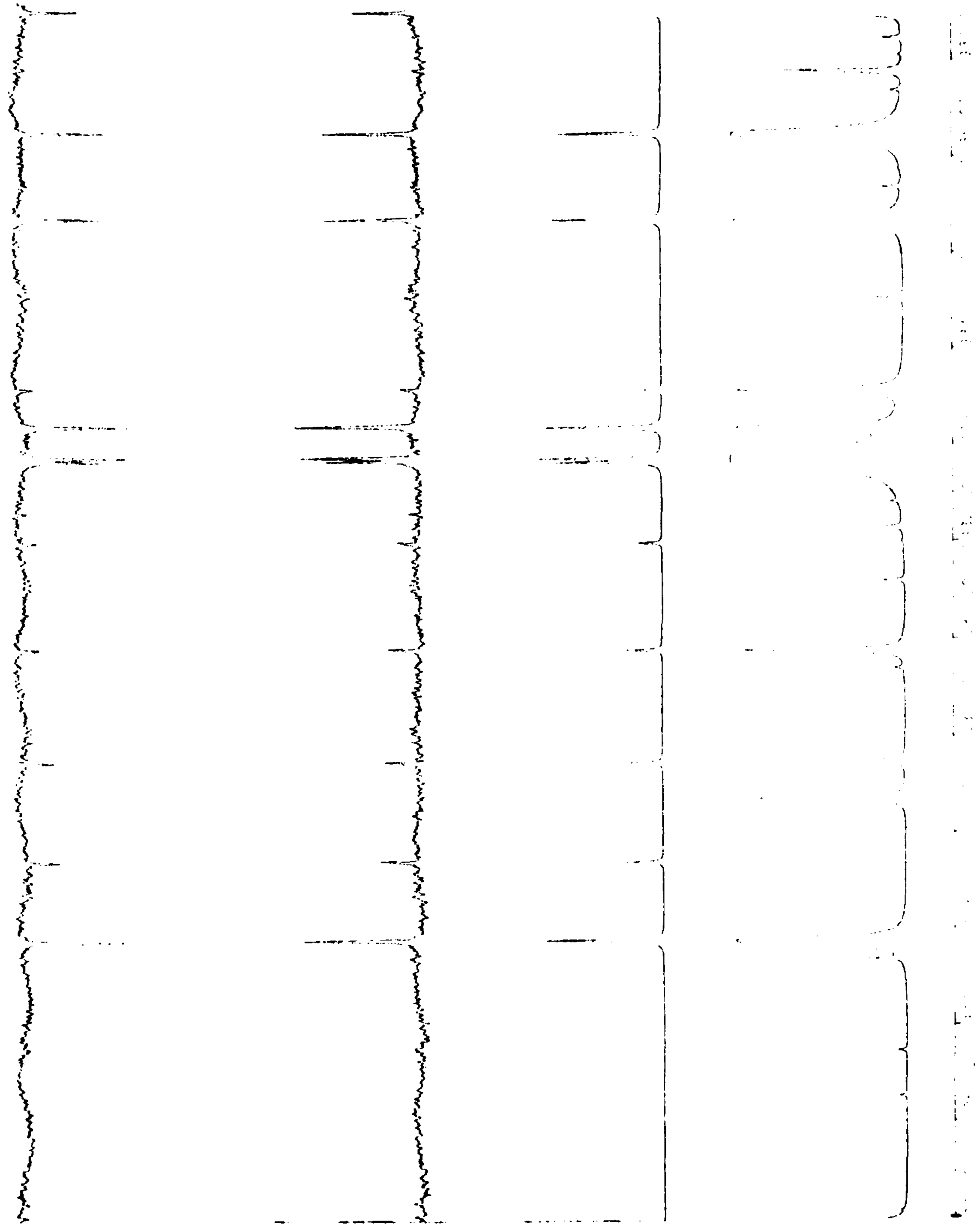


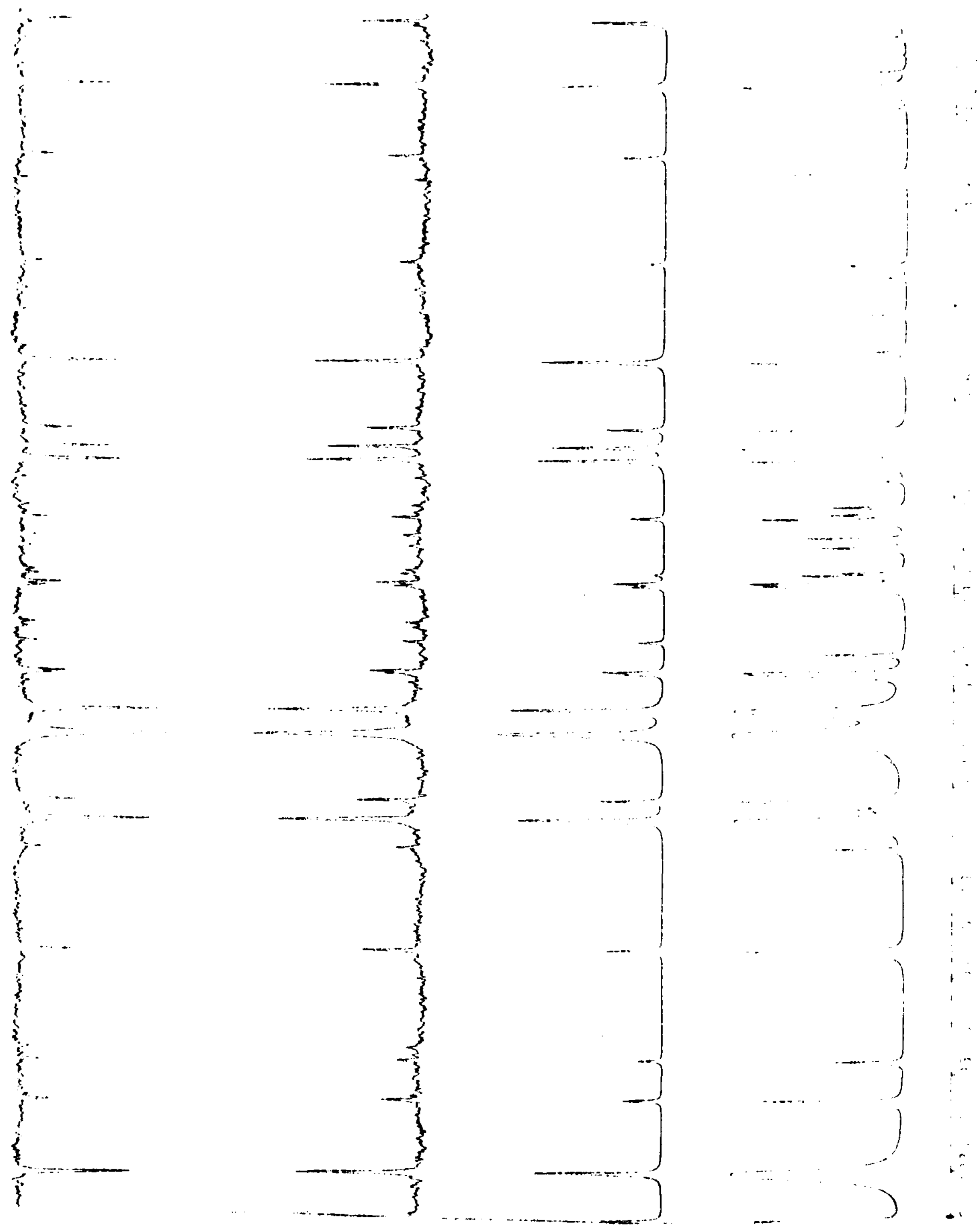


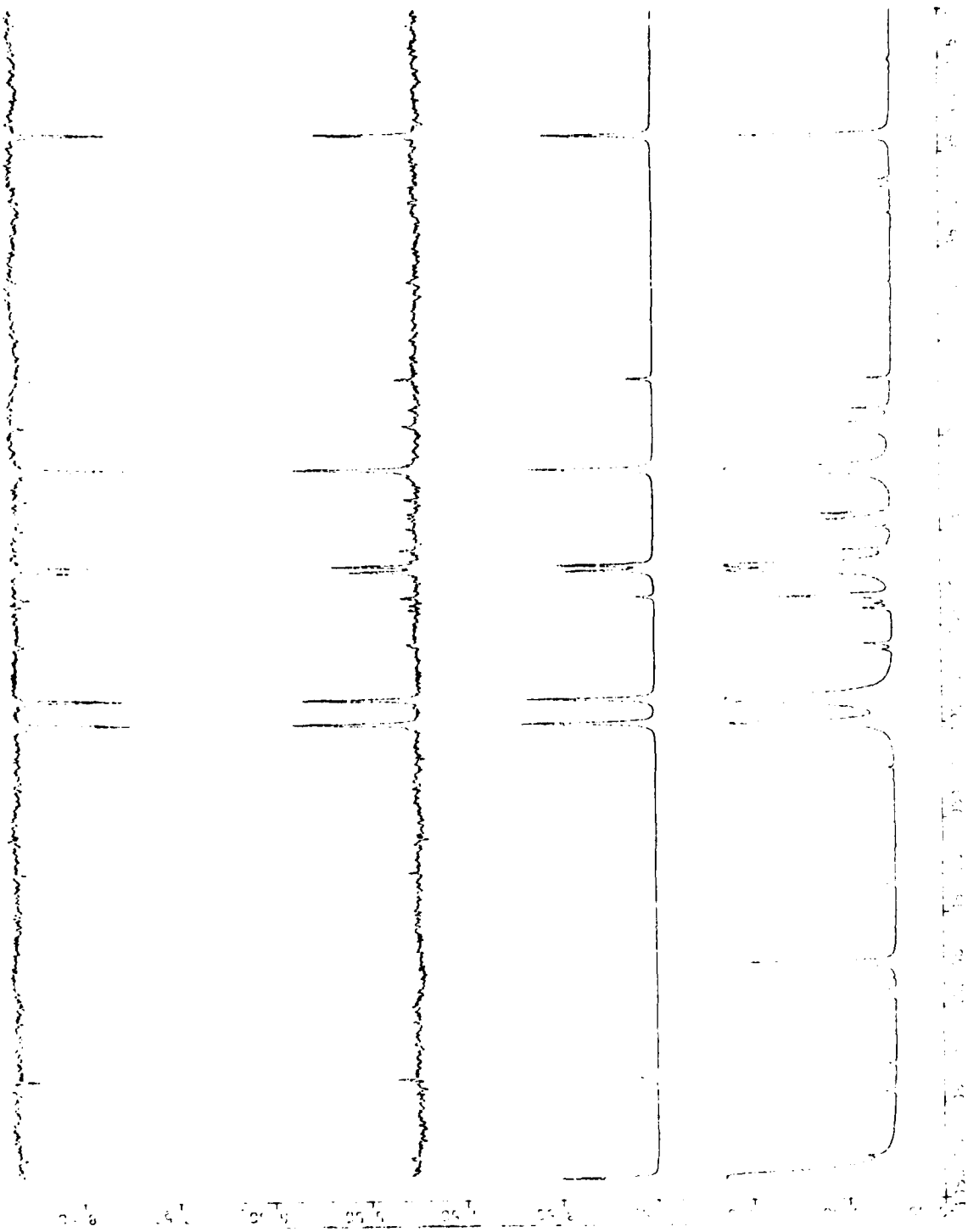


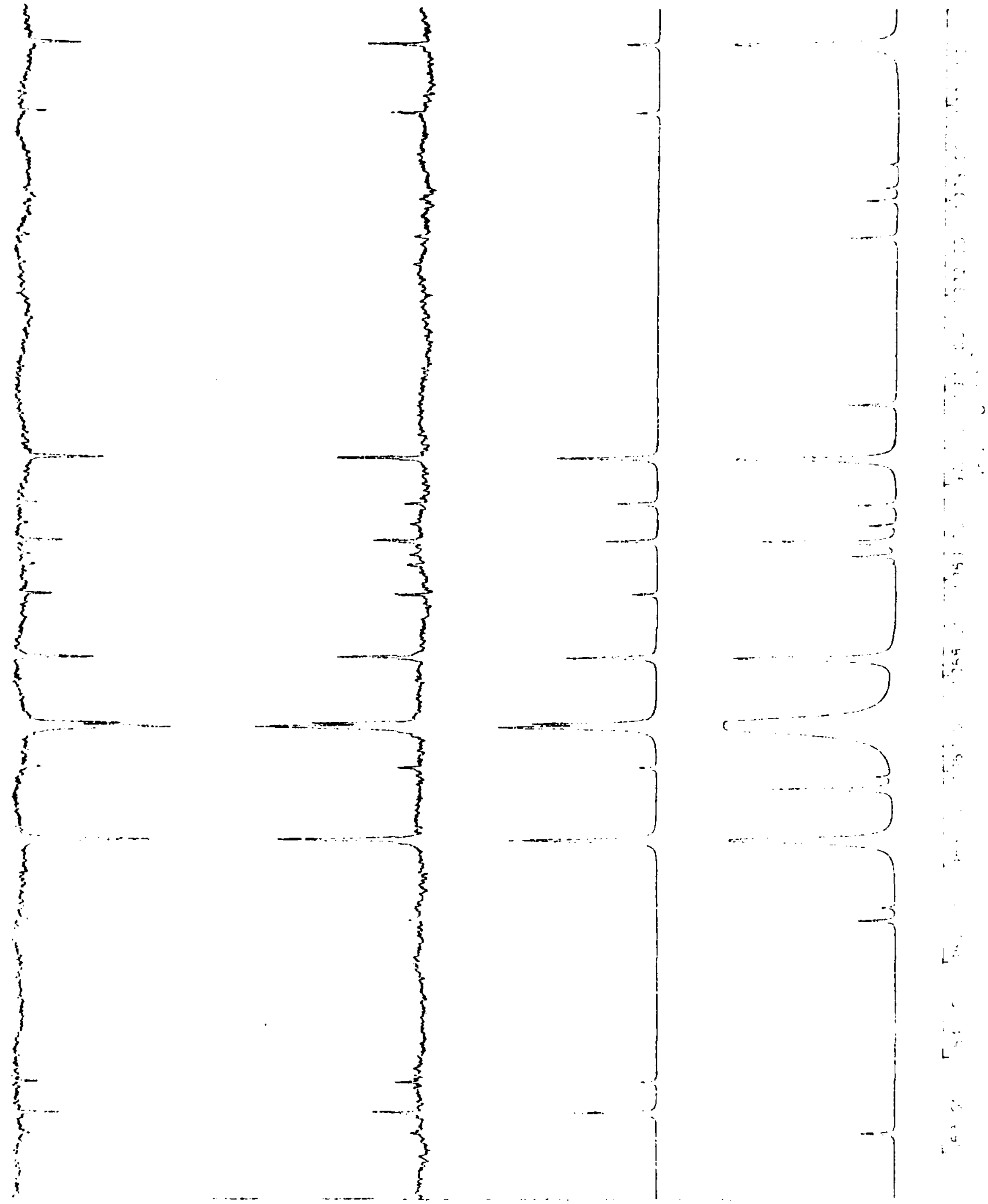












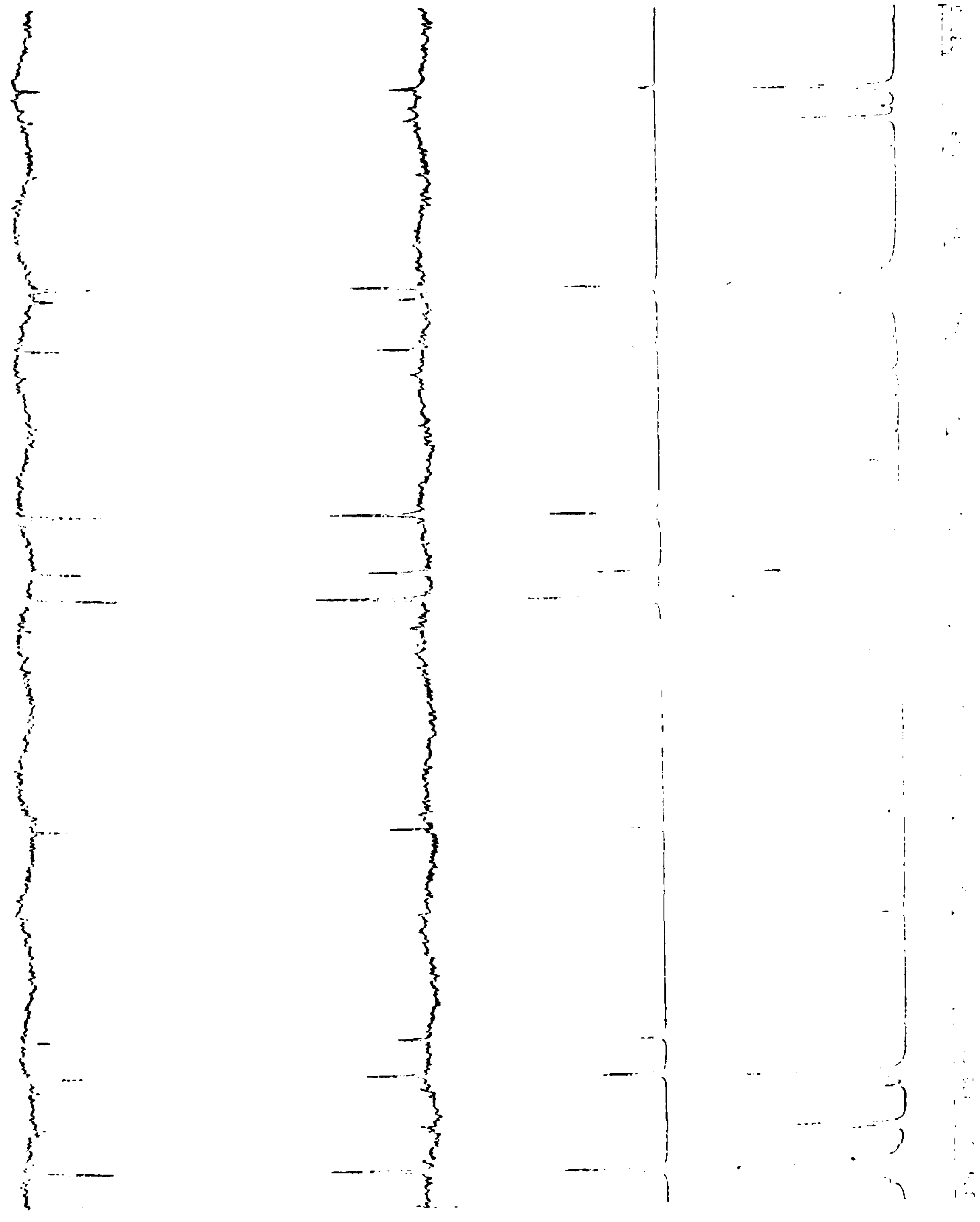


Table I

H_2O line data between 1600 cm^{-1} and 2000 cm^{-1}.

The listings are:

the transition frequency in cm^{-1}

the absorption strength in cm^{-1}/molecule cm^{-2} at 800°K

the integrated absorptance in cm^{-1} for the H_2O column density 2.17 x 10^{20} molecules/cm^2 at 800°K

the lower state energy in cm^{-1}

the transition assignment in (J', KA', KC'), (J", KA", KC"), (ν_1', ν_2', ν_3'), and (ν_1", ν_2", ν_3")

the internal code

the isotope code

the molecule identification code

the integrated absorptance, and

the wavenumber difference between the measured and the one listed in the AFGL listing.

Table I

1641.9543	.376E-22	.013	1611.324	2	5	7	11	5	6	0	1	0	0	0	0	16	162	1	.003	-.0283
1642.7498	.919E-21	.014	448.104	6	3	7	4	4	1	0	1	0	0	0	0	180	161	1	.019	-.0005
1644.6300	.100E-23	.020	1320.764	5	1	4	3	0	5	0	2	0	0	1	0	180	161	1	.020	-.0050
1645.2675	.526E-19	.165	173.365	7	2	1	3	1	2	0	1	0	0	0	0	180	161	1	.165	.0034
1646.2940	.242E-21	.007	23.755	2	1	3	1	0	1	0	1	0	0	0	0	16	181	1	.007	.0030
1647.4034	.374E-20	.070	275.497	4	2	2	4	1	3	0	1	0	0	0	0	180	161	1	.070	.0015
1647.5631	.206E-21	.006	108.364	5	2	3	5	1	4	0	1	0	0	0	0	16	181	1	.006	.0073
1647.9412	.376E-22	.003	2733.965	5	5	0	5	5	1	1	0	0	0	1	0	180	161	1	.003	-.0022
1647.9412	.376E-22	.003	2733.965	5	5	1	6	6	0	1	0	0	0	1	0	180	161	1	.003	-.0022
1648.2659	.765E-21	.017	1773.485	7	2	2	3	1	3	0	2	0	0	1	0	180	161	1	.017	-.0699
1648.3119	.598E-21	.060	95.176	2	2	0	2	1	1	0	1	0	0	0	0	180	161	1	.060	.0041
1649.4220	.270E-21	.007	756.725	5	5	0	6	4	3	0	1	0	0	0	0	180	161	1	.007	-.0010
1649.9073	.331E-20	.034	1731.898	4	1	4	3	3	3	0	2	0	0	1	0	180	161	1	.034	-.0013
1650.2673	.975E-22	.003	1255.167	7	6	1	8	5	4	0	1	0	0	0	0	180	161	1	.003	.0001
1651.6555	.376E-22	.003	1874.374	9	7	2	10	5	5	0	1	0	0	0	0	180	161	1	.003	.0005
1652.1983	.275E-20	.029	2238.382	5	5	0	6	4	3	0	2	0	0	1	0	180	161	1	.029	.0027
1652.3960	.381E-19	.144	73.496	3	0	3	2	1	2	0	1	0	0	0	0	180	161	1	.144	.0063
1652.4751	.757E-20	.059	509.912	6	2	5	5	3	2	0	1	0	0	0	0	180	161	1	.059	-.0011
1652.8116	.130E-20	.023	842.757	8	2	7	7	3	4	0	1	0	0	0	0	180	161	1	.023	0.0000
1653.2649	.570E-19	.181	23.734	2	1	2	1	0	1	0	1	0	0	0	0	180	161	1	.181	.0031
1653.4195	.502E-20	.055	222.052	4	1	3	4	0	4	0	1	0	0	0	0	180	161	1	.055	.0035
1654.4576	.237E-21	.006	2399.382	7	3	4	6	4	3	0	2	0	0	1	0	180	161	1	.006	-.0036
1654.5113	.333E-19	.131	399.457	5	2	3	5	1	4	0	1	0	0	0	0	180	161	1	.131	.0007
1656.3055	.324E-21	.015	742.076	5	4	3	5	5	0	0	1	0	0	0	0	180	161	1	.015	.0004
1656.9315	.799E-21	.017	661.549	7	2	6	5	3	3	0	1	0	0	0	0	180	161	1	.017	.0005
1657.0375	.264E-21	.007	742.077	6	4	2	5	5	1	0	1	0	0	0	0	180	161	1	.007	-.0005
1657.3919	.288E-20	.036	1421.599	5	0	5	4	1	4	0	2	0	0	1	0	180	161	1	.036	-.0039
1657.4336	.107E-20	.021	1308.017	5	1	4	4	2	3	0	2	0	0	1	0	180	161	1	.021	-.0026
1657.5704	.318E-21	.008	2724.158	8	4	5	7	5	2	0	2	0	0	1	0	180	161	1	.008	-.0036
1657.7591	.135E-20	.029	2309.731	7	2	5	7	1	6	0	2	0	0	1	0	180	161	1	.029	-.0011
1658.2714	.168E-21	.005	2126.407	6	2	4	5	3	3	0	2	0	0	1	0	180	161	1	.005	-.0004
1659.8415	.376E-22	.003																	.003	0.0000
1661.2462	.116E-20	.022	2332.594	7	3	4	7	2	5	0	2	0	0	1	0	180	161	1	.022	-.0042
1660.4688	.330E-21	.019	1821.599	4	2	3	4	1	4	0	2	0	0	1	0	180	161	1	.019	-.0038
1661.3725	.243E-20	.030	610.341	6	3	4	5	4	1	0	1	0	0	0	0	180	161	1	.030	0.0000
1662.6044	.106E-20	.021	2211.192	6	3	3	6	2	4	0	2	0	0	1	0	180	161	1	.021	-.0336
1662.8109	.172E-19	.095	73.406	2	2	1	2	1	2	0	1	0	0	0	0	180	161	1	.095	.0002
1664.0647	.333E-21	.009	2595.813	8	3	5	8	2	6	0	2	0	0	1	0	180	161	1	.009	.0023
1664.3566	.651E-22	.002																	.002	0.0000
1665.0304	.777E-21	.017	1317.451	5	1	5	4	0	4	0	2	0	0	1	0	180	161	1	.017	-.0314
1668.2477	.537E-20	.051	542.906	6	2	4	6	1	5	0	1	0	0	0	0	180	161	1	.051	-.0017
1668.7562	.124E-20	.023	2253.953	5	3	2	5	2	3	0	2	0	0	1	0	180	161	1	.023	-.0022
1669.1702	.318E-20	.034	226.301	4	1	3	3	2	2	0	1	0	0	0	0	180	161	1	.039	.0028
1669.3066	.594E-19	.193	73.031	3	1	3	2	0	2	0	1	0	0	0	0	180	161	1	.193	-.0026
1670.9710	.133E-21	.004	2408.768	10	3	8	9	4	5	0	2	0	0	1	0	180	161	1	.004	.0030
1671.3143	.430E-21	.011	2041.784	6	1	5	6	0	6	0	2	0	0	1	0	180	161	1	.011	-.0050
1671.4525	.357E-20	.041	342.517	5	2	3	4	3	2	0	1	0	0	0	0	180	161	1	.041	0.0000
1671.5132	.645E-20	.057	142.278	3	2	2	3	1	3	0	1	0	0	0	0	180	161	1	.057	.0039
1672.4761	.794E-21	.017	510.114	6	3	3	5	4	2	0	1	0	0	0	0	180	161	1	.017	.0003
1674.1781	.237E-21	.007	1190.835	6	5	1	7	5	2	0	1	0	0	0	0	180	161	1	.007	.0003
1674.3157	.376E-22	.003	1671.344	8	7	2	9	6	3	0	1	0	0	0	0	180	161	1	.003	-.0037
1675.1725	.129E-19	.132	142.274	4	1	4	3	1	3	0	1	0	0	0	0	180	161	1	.132	-.0005
1675.4078	.364E-21	.019	2219.338	9	1	6	9	2	7	0	2	0	0	1	0	180	161	1	.019	-.0005
1675.5172	.133E-19	.089	775.348	5	1	4	5	0	5	0	1	0	0	0	0	180	161	1	.089	.0004
1675.6400	.162E-19	.029	1542.504	2	2	1	1	1	0	0	2	0	0	1	0	180	161	1	.029	-.0032
1675.8185	.339E-21	.013	1333.331	5	2	4	5	1	3	0	2	0	0	1	0	180	161	1	.013	-.0035
1677.1761	.331E-21	.014	1393.307	4	3	1	4	1	2	0	2	0	0	1	0	180	161	1	.014	-.0012
1677.2233	.144E-20	.023	1171.471	5	1	6	5	1	5	0	2	0	0	1	0	180	161	1	.023	-.0010
1677.7804	.167E-21	.005	186.113	4	1	4	3	0	3	0	1	0	0	0	0	16	181	1	.005	.0032
1678.0331	.651E-22	.002																	.002	0.0000
1678.0458	.148E-21	.005	1048.053	7	5	3	6	5	0	0	1	0	0	0	0	180	161	1	.005	-.0005
1679.1105	.401E-21	.009	1047.053	7	5	2	6	6	1	0	1	0	0	0	0	180	161	1	.009	-.0005
1679.2665	.551E-22	.002																	.002	0.0000
1679.7473	.551E-22	.002																	.002	0.0000
1679.4703	.137E-21	.004	775.749	4	1	2	5	0	5	0	1	0	0	0	0	180	161	1	.004	-.0015

1679.4173	[illegible]	[illegible]	[illegible]	6	3	[illegible]	6	[illegible]	4	0	1	0	0	0	0	180	161	1	.053	.0001
1680.4664	[illegible]	[illegible]	[illegible]	7	3	4	7	5	5	0	1	0	0	0	0	180	161	1	.079	-.0009
1680.8765	[illegible]	.011	444.637	7	4	4	6	5	1	0	1	0	0	0	0	180	161	1	.011	-.0015
1681.0328	.400E-27	[illegible]	[illegible]	6	4	6	5	[illegible]	5	0	2	0	0	[illegible]	[illegible]	180	161	1	.040	-.0028
1681.1643	.714E-21	[illegible]	[illegible]	3	4	0	3	2	1	[illegible]	2	0	0	1	[illegible]	180	161	1	.016	-.0023
1682.1753	.440E-21	.017	[illegible]	7	[illegible]	[illegible]	6	4	2	0	1	0	0	0	0	180	161	1	.017	.0007
1682.2450	.693E-21	.016	1634.373	2	2	0	1	1	1	0	2	0	0	1	0	180	161	1	.016	-.0040
1682.4737	[illegible]	[illegible]	2437.355	3	3	5	8	1	7	0	2	0	0	1	0	180	161	1	.019	-.0037
1683.1795	.179E-17	[illegible]	[illegible]	4	3	3	4	[illegible]	4	0	1	0	0	0	0	180	161	1	.092	-.0005
1683.5419	.151E-20	[illegible]	349.593	7	4	3	5	5	2	0	1	0	0	0	0	180	161	1	.023	-.0009
1683.9925	.256E-19	.117	446.511	5	3	2	5	2	3	0	1	0	0	0	0	180	161	1	.113	.0015
1684.8658	.794E-19	.237	[illegible]	4	[illegible]	4	3	0	3	0	1	0	0	0	0	180	161	1	.207	-.0088
1685.4725	.232E-20	.327	546.263	6	3	4	7	0	7	0	1	0	0	0	0	180	161	1	.027	-.0035
1686.7253	.336E-21	[illegible]	1413.784	3	3	1	3	2	2	0	2	0	0	1	0	180	161	1	.009	-.0033
1687.8785	.273E-26	.316	242.912	8	3	[illegible]	8	2	6	0	1	0	0	0	0	180	161	1	.036	.0004
1688.3735	.122E-17	.075	[illegible]	7	2	5	7	1	6	0	1	0	0	0	0	180	161	1	.075	.0005
1688.9302	.337E-21	[illegible]	[illegible]	6	1	5	5	2	4	0	2	0	0	1	0	180	161	1	.010	.0019
1689.1965	.171E-21	[illegible]	[illegible]	[illegible]	[illegible]	5	4	1	4	0	1	0	0	0	0	16	181	1	.004	.0014
1689.8538	.905E-21	.317	1408.017	4	3	2	4	2	3	0	2	0	0	1	0	180	161	1	.017	-.0019
1690.1785	.555E-21	.056	[illegible]	4	3	1	4	2	2	0	1	0	0	0	0	180	161	1	.056	-.0005
1691.3683	.376E-22	[illegible]	[illegible]	8	3	5	7	4	4	0	2	0	0	1	0	180	161	1	.003	.0037
1692.1634	.133E-21	.004	[illegible]	9	4	5	8	3	4	0	2	0	0	1	0	180	161	1	.004	-.0026
1693.4186	.306E-21	.017	[illegible]	6	2	5	6	1	6	0	2	0	0	1	0	180	161	1	.017	-.0026
1693.4194	.833E-21	[illegible]	[illegible]	12	7	10	11	4	7	0	1	0	0	0	0	180	161	1	.017	-.0014
1693.5263	.551E-22	[illegible]																	.002	0.0000
1693.7013	[illegible]	[illegible]	[illegible]	3	4	6	10	4	7	1	0	0	0	1	0	180	161	1	.002	-.0140
1694.0395	.745E-21	.017	1643.652	3	2	2	2	1	1	0	2	0	0	1	0	180	161	1	.017	-.0025
1694.1773	.262E-21	[illegible]	[illegible]	6	4	3	7	1	5	0	1	0	0	0	0	180	161	1	.007	-.0090
1694.3753	.356E-21	[illegible]	[illegible]	12	3	7	10	2	8	0	2	0	0	1	0	180	161	1	.007	.0071
1695.3415	.497E-21	[illegible]	[illegible]	5	3	3	5	2	4	0	2	0	0	1	0	180	161	1	.012	.0004
1695.4591	.161E-19	.089	[illegible]	3	3	0	7	2	1	0	1	0	0	0	0	180	161	1	.089	.0011
1695.7773	[illegible]	[illegible]	[illegible]	7	2	5	6	3	4	0	2	0	0	1	0	180	161	1	.013	[illegible]
1695.9554	[illegible]	[illegible]	[illegible]	7	0	7	6	1	6	0	2	0	0	1	0	180	161	1	.019	-.0018
1696.3347	.966E-17	[illegible]	[illegible]	5	0	5	4	1	4	0	1	0	0	0	0	180	161	1	.212	.0063
1697.5285	.362E-20	[illegible]	[illegible]	5	2	4	5	1	5	0	1	0	0	0	0	180	161	1	.039	-.0035
1697.7794	.112E-22	[illegible]	[illegible]	7	1	7	6	0	6	0	2	0	0	1	0	180	161	1	.019	-.0044
1698.3059	.376E-22	[illegible]																	.003	0.0001
1698.6367	.761E-21	.015	2143.664	7	1	6	7	0	7	0	2	0	0	1	0	180	161	1	.015	-.0012
1698.9556	.157E-20	.024	[illegible]	8	3	6	7	4	3	0	1	0	0	0	0	180	161	1	.024	.0014
1699.5691	.167E-20	[illegible]	446.637	6	1	5	5	0	5	0	1	0	0	0	0	180	161	1	.043	-.0001
1699.9731	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	0	0	1	0	0	0	0	180	161	1	.173	-.0041
[illegible]	[illegible]	[illegible]	[illegible]	6	1	4	4	2	3	0	1	0	0	0	0	180	161	1	.098	-.0007
[illegible]	[illegible]	[illegible]	[illegible]	5	1	5	4	0	4	0	1	0	0	0	0	180	161	1	.097	-.0010
[illegible]	.464E-20	[illegible]	[illegible]	12	4	7	9	5	4	0	2	0	0	1	0	180	161	1	.038	.0027
[illegible]	[illegible]	[illegible]	[illegible]	3	3	1	3	2	2	0	1	0	0	0	0	180	161	1	.039	-.0001
[illegible]	.171E-21	[illegible]	[illegible]	[illegible]	4	5	10	3	[illegible]	0	2	0	0	1	0	180	161	1	.004	.0095
1702.6053	.651E-22	[illegible]																	.002	0.0003
[illegible]	[illegible]	[illegible]	[illegible]	3	3	6	9	2	7	0	1	0	0	0	0	180	161	1	.044	.0004
[illegible]	[illegible]	[illegible]	[illegible]	6	4	1	6	5	2	1	0	0	0	1	0	180	161	1	.007	.0136
[illegible]	[illegible]	[illegible]	[illegible]	8	5	4	7	6	1	0	1	0	0	0	0	180	161	1	.011	.0013
[illegible]	[illegible]	[illegible]	[illegible]	6	3	4	6	2	5	0	2	0	0	1	0	180	161	1	.017	-.0007
[illegible]	[illegible]	[illegible]	[illegible]	4	0	3	7	6	2	0	1	0	0	0	0	180	161	1	.013	-.0004
[illegible]	[illegible]	[illegible]	[illegible]	4	3	2	4	3	3	0	1	0	0	0	0	180	161	1	.079	-.0004
[illegible]	[illegible]	[illegible]	[illegible]	8	4	5	7	5	2	0	1	0	0	0	0	180	161	1	.023	.0003
[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]	4	5	4	[illegible]	0	1	0	0	0	0	180	161	1	.033	-.0013
[illegible]	[illegible]	[illegible]	[illegible]	4	6	3	[illegible]	7	0	0	1	0	0	0	0	180	161	1	.025	-.0149
[illegible]	[illegible]	[illegible]	[illegible]	3	6	[illegible]	[illegible]	[illegible]	1	0	1	0	0	0	0	180	161	1	.025	.0052
[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]	1	1	1	0	1	0	0	0	0	180	161	1	.053	.0039
[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]	10	4	6	0	1	0	0	0	0	180	161	1	.025	-.0015
[illegible]	[illegible]	[illegible]	[illegible]	3	4	5	[illegible]	3	6	0	2	0	0	1	0	180	161	1	.021	-.0013
[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]	4	5	3	3	0	1	0	0	0	0	180	161	1	.035	.0008
[illegible]	[illegible]	[illegible]																	.003	0.0000
[illegible]	[illegible]	[illegible]	1272.413	4	2	3	3	1	2	0	2	0	0	1	0	180	161	1	.033	-.0026
[illegible]	[illegible]	[illegible]	[illegible]	5	[illegible]	3	5	[illegible]	4	0	1	0	0	0	0	180	161	1	.045	-.0015
[illegible]	[illegible]	[illegible]	[illegible]	6	1	[illegible]	[illegible]	[illegible]	5	0	1	0	0	0	0	16	181	1	.005	.0134

1711.4635	.371E-21	.016	2634.190	9	2	7	3	[illegible]	8	0	2	0	0	1	0	180	161	1	.016	-.0006
1712.0447	.466E-21	.011	1053.647	8	4	4	7	5	3	0	1	0	0	0	0	180	161	1	.011	-.0007
1712.3460	.135E-21	.004	3734.544	12	4	8	12	3	9	0	2	0	0	1	0	180	161	1	.004	-.1520
1712.4424	.976E-22	.003																	.003	0.0000
1712.4323	.111E-20	.029	1360.236	10	3	8	9	4	5	0	1	0	0	0	0	180	161	1	.029	-.0009
1712.7218	.190E-20	.027	482.891	8	2	6	8	1	7	0	1	0	0	0	0	180	161	1	.027	-.0029
1713.0782	.377E-21	.009	2181.092	7	2	6	7	1	7	0	2	0	0	1	0	180	161	1	.009	-.0022
1713.6647	.651E-22	.002																	.002	0.0000
1713.9103	.163E-20	.013	2181.292	8	0	8	7	1	7	0	2	0	0	1	0	180	161	1	.013	-.0023
1714.0757	.158E-19	.079	447.252	6	2	5	6	1	6	0	1	0	0	0	0	180	161	1	.079	-.0017
1714.5116	.570E-20	.036	2190.644	8	1	8	7	0	7	0	2	0	0	1	0	180	161	1	.036	-.0026
1715.0749	.411E-21	.010	2718.541	7	3	5	7	2	6	0	2	0	0	1	0	180	161	1	.010	.0001
1715.1576	.250E-17	.101	326.625	6	0	6	5	1	5	0	1	0	0	0	0	180	161	1	.101	.0015
1715.5254	.225E-20	.032	2670.792	8	4	4	8	3	5	0	2	0	0	1	0	180	161	1	.032	-.0026
1715.5898	.164E-20	.020	1538.150	10	4	6	10	3	7	0	1	0	0	0	0	180	161	1	.020	-.0009
1715.6392	.366E-21	.020	1677.163	3	2	1	2	1	2	0	2	0	0	1	0	180	161	1	.020	-.0032
1715.9679	.435E-20	.045	1292.917	9	4	6	9	3	6	0	1	0	0	0	0	180	161	1	.045	.0002
1716.5702	.132E-21	.004	2670.792	9	0	8	9	3	5	1	0	0	0	1	0	180	161	1	.004	-.0032
1717.4109	.115E-18	.219	325.348	6	1	6	5	[illegible]	5	0	1	0	0	0	0	180	161	1	.219	-.0039
1718.0519	.225E-20	.029	2161.296	7	1	6	6	2	5	0	2	0	0	1	0	180	161	1	.029	-.0009
1718.8120	.108E-19	.076	95.176	3	2	2	2	1	1	0	1	0	0	0	0	180	161	1	.076	.0010
1718.8319	.134E-19	.066	552.912	6	3	4	6	2	5	0	1	0	0	0	0	180	161	1	.066	-.0009
1719.5341	.316E-21	.009	3314.957	11	3	8	11	2	9	0	2	0	0	1	0		161	1	.009	-.0851
1721.5325	.166E-20	.027	1050.159	8	4	4	8	3	5	0	1	0	0	0	0	180	161	1	.027	.0004
1722.3226	.376E-22	.003																	.003	0.0000
1722.5987	.651E-22	.002	2146.265	5	4	2	6	1	5	0	2	0	0	1	0	180	161	1	.002	.0193
1722.6482	.205E-20	.029	1413.274	11	4	7	11	3	9	0	1	0	0	0	0	180	161	1	.029	-.0012
1723.0475	.576E-21	.015	1375.474	5	2	4	4	1	3	0	2	0	0	1	0	180	161	1	.015	-.0055
1723.4957	.437E-20	.042	585.247	7	1	6	7	0	7	0	1	0	0	0	0	180	161	1	.042	.0013
1724.2912	.114E-20	.020	1637.969	10	3	7	10	2	9	0	1	0	0	0	0	180	161	1	.020	-.0012
1724.5903	.651E-22	.002																	.002	0.0000
1725.3752	.272E-21	.006	2237.469	8	1	7	8	2	9	0	2	0	0	1	0	180	161	1	.005	-.0062
1725.5159	.572E-21	.013	2462.476	7	4	3	7	3	4	0	2	0	0	1	0	180	161	1	.013	-.0019
1726.1335	.376E-22	.003																	.003	0.0000
1726.3344	.651E-22	.002																	.002	0.0008
1726.7253	.976E-22	.003	172.994	4	2	3	3	1	2	0	1	0	0	0	0	16	181	1	.003	-.0073
1727.4127	.374E-21	.009	1355.913	9	4	6	8	5	3	0	1	0	0	0	0	180	161	1	.009	-.0003
1727.9355	.197E-21	.005	1411.467	9	5	5	9	5	2	0	1	0	0	0	0	180	161	1	.005	-.0045
1728.8758	.651E-22	.002	2665.144	4	4	1	5	5	0	1	0	0	0	1	0	180	161	1	.002	-.0019
1729.0094	.976E-22	.003	4422.413	13	4	9	13	3	12	0	2	0	0	1	0	180	161	1	.003	.0025
1729.1566	.170E-21	.005	[illegible]	9	3	6	8	4	5	0	2	0	0	1	0	180	161	1	.005	.0005
1729.1501	.376E-22	.003																	.003	0.0000
1729.4746	.186E-20	.024	2495.154	9	3	6	9	2	7	0	2	0	0	1	0	180	161	1	.024	-.0160
1729.4740	.189E-20	.024	1411.612	9	5	4	9	5	3	0	1	0	0	0	0	180	161	1	.024	.0010
1729.7832	.391E-20	.043	342.757	7	4	3	7	3	4	0	1	0	0	0	0	180	161	1	.043	-.0002
1729.8147	.526E-20	.036	3526.030	9	6	3	9	7	2	1	0	0	0	1	0	180	161	1	.036	.0143
1730.1544	.912E-20	.057	[illegible]	6	1	5	5	2	4	0	1	0	0	0	0	180	161	1	.057	.0012
1730.2409	.976E-22	.003	1343.631	9	6	4	8	7	1	0	1	0	0	0	0	180	161	1	.003	.0012
1730.7471	.359E-20	[illegible]	[illegible]	7	3	5	7	7	5	0	1	0	0	0	0	180	161	1	.035	-.0001
[illegible]	[illegible]	.032	[illegible]	9	[illegible]	[illegible]	9	1	9	0	2	0	0	1	0	180	161	1	.032	-.0023
1731.4688	.211E-20	.019	[illegible]	9	1	4	8	[illegible]	9	0	2	0	0	1	0	180	161	1	.019	-.0049
1732.1524	[illegible]	[illegible]	986.479	7	2	6	7	1	7	0	1	0	0	0	0	180	161	1	.025	-.0006
1733.2723	[illegible]	[illegible]	[illegible]	8	2	6	7	3	5	0	2	0	0	1	0	180	161	1	.009	-.0033
1733.3120	.503E-20	[illegible]	467.252	7	1	7	6	1	6	0	1	0	0	0	0	180	151	1	.141	-.0010
1733.4637	[illegible]	[illegible]	[illegible]	6	4	2	6	3	3	0	2	0	0	1	0	180	161	1	[illegible]	-.0017
[illegible]	[illegible]	[illegible]	[illegible]	9	2	7	9	1	9	0	2	0	0	1	0	180	161	1	.015	-.0035
1734.7056	[illegible]	[illegible]	[illegible]	7	[illegible]	7	5	0	6	0	1	0	0	0	0	180	161	1	.103	-.0004
[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	3	3	1	2	0	1	0	0	0	0	180	161	1	.134	-.0010
1735.2157	[illegible]	[illegible]	[illegible]	11	5	6	10	6	5	0	2	0	0	1	0		161	1	.003	.1553
[illegible]	[illegible]	[illegible]	[illegible]	6	2	5	5	1	4	0	2	0	0	1	0	190	161	1	.029	-.0041
1737.0441	[illegible]	.017	[illegible]	12	4	8	12	3	9	0	1	0	0	0	0	180	161	1	.012	-.0061
1737.5961	[illegible]	.014	1733.041	9	3	3	8	9	0	0	1	0	0	0	0	180	161	1	.014	-.0101
1737.6175	.129E-20	.029	441.543	6	4	2	6	3	3	0	1	0	0	0	0	180	161	1	.029	-.0005
1738.4374	.676E-21	.015	[illegible]	5	4	1	5	3	2	0	2	0	0	1	0	180	161	1	.015	-.0014
1739.1193	.543E-20	.047	1379.043	9	3	3	9	1	8	0	1	0	0	0	0	180	161	1	.043	-.0009

1739.9731	.2625E-19	.117	79.496	3	2	1	2	1	2	0	1	0	0	0	0	180	161	1	.117	.0013
1740.9629	.4747E-20	.042	3005.917	4	4	0	4	3	1	0	2	0	0	1	0	180	161	1	.042	-.0013
1741.3640	.4046E-21	.010	2604.317	4	4	1	4	3	2	0	2	0	0	1	0	180	161	1	.010	-.0020
1742.4574	.3643E-21	.009	2125.457	5	4	2	5	3	3	0	2	0	0	1	0	180	161	1	.009	-.0014
1742.9175	.7284E-20	.059	927.744	8	3	5	7	4	4	0	1	0	0	0	0	180	161	1	.059	-.0042
1743.0812	.7835E-20	.059	508.312	5	4	1	5	3	2	0	1	0	0	0	0	180	161	1	.059	-.0002
1743.6155	.1146E-19	.073	448.979	7	2	5	6	3	4	0	1	0	0	0	0	180	161	1	.073	.0005
1743.8034	.3537E-21	.014	2271.722	6	4	3	6	3	4	0	2	0	0	1	0	180	161	1	.014	-.0004
1744.2931	.1212E-20	.017	2313.541	8	1	7	7	2	6	0	2	0	0	1	0	180	161	1	.017	-.0031
1744.5933	.4772E-20	.039	385.601	8	3	6	8	2	7	0	1	0	0	0	0	180	161	1	.039	.0007
1745.7771	.1885E-20	.027	383.942	4	4	0	4	3	1	0	1	0	0	0	0	180	161	1	.027	-.0011
1746.2916	.2033E-20	.023	744.364	8	1	7	8	0	8	0	1	0	0	0	0	180	161	1	.023	-.0006
1746.3491	.1616E-21	.004	2690.595	9	3	7	9	2	8	0	2	0	0	1	0	180	161	1	.004	.0053
1746.6157	.3575E-21	.009	2431.956	7	4	4	7	3	5	0	2	0	0	1	0	180	161	1	.009	-.0003
1747.0837	.5326E-20	.049	382.517	4	4	1	4	3	2	0	1	0	0	0	0	180	161	1	.049	-.0007
1747.2555	.1135E-20	.019	1477.297	10	4	7	9	5	4	0	1	0	0	0	0	180	161	1	.019	.0006
1747.5585	.1455E-21	.004	584.937	9	1	8	7	0	7	0	1	0	0	0	0	16	171	1	.004	.0095
1747.7292	.2545E-20	.032	503.364	5	4	2	5	3	3	0	1	0	0	0	0	180	151	1	.032	-.0002
1747.9052	.3326E-21	.017	2146.265	7	2	6	6	1	5	0	2	0	0	1	0	180	161	1	.017	-.0022
1747.9775	.2696E-20	.019	2512.378	10	0	10	9	1	9	0	2	0	0	1	0	180	161	1	.019	-.0045
1748.1846	.9405E-20	.035	2512.383	10	1	10	9	0	9	0	2	0	0	1	0	180	161	1	.035	.0004
1748.6552	.4505E-20	.056	275.497	5	2	4	4	1	3	0	1	0	0	0	0	180	161	1	.056	-.0032
1749.4035	.4687E-20	.058	648.979	6	4	3	6	3	4	0	1	0	0	0	0	180	161	1	.058	.0005
1750.3233	.3766E-22	.003	550.454	7	1	6	6	2	5	0	1	0	0	0	0	16	181	1	.003	.0047
1750.3762	.1567E-20	.022	1693.665	11	3	8	11	2	9	0	1	0	0	0	0	180	161	1	.022	-.0011
1750.9293	.3207E-21	.013	2512.233	9	1	9	9	0	9	0	2	0	0	1	0	180	161	1	.013	.0375
1750.9477	.5535E-19	.119	596.479	8	0	8	7	1	7	0	1	0	0	0	0	180	161	1	.119	.0003
1751.0320	.5295E-19	.119	744.163	8	2	7	9	1	8	0	1	0	0	0	0	180	161	1	.119	.0030
1751.4761	.6333E-19	.123	595.243	8	1	8	7	0	7	0	1	0	0	0	0	180	161	1	.123	-.0001
1751.5429	.4221E-21	.010	2430.194	9	4	5	9	3	6	0	2	0	0	1	0	180	161	1	.010	-.0029
1751.8559	.5176E-21	.012	2533.793	13	5	9	13	4	9	0	1	0	0	0	0	180	161	1	.012	.0001
1751.8831	.7375E-21	.014	1631.786	10	5	6	9	6	3	0	1	0	0	0	0	180	151	1	.014	-.0010
1752.4157	.2143E-20	.025	918.634	7	4	4	7	3	5	0	1	0	0	0	0	180	161	1	.025	-.0012
1753.5313	.7015E-21	.009	2205.572	12	5	7	12	4	9	0	1	0	0	0	0	180	161	1	.009	.0017
1754.1177	.6285E-21	.009	1410.589	10	6	5	9	7	2	0	1	0	0	0	0	180	161	1	.009	-.0007
1754.4213	.1675E-21	.004	1410.584	10	6	4	9	7	3	0	1	0	0	0	0	180	161	1	.004	-.0013
1755.8652	.3765E-22	.003	2512.373	9	2	8	9	1	9	0	2	0	0	1	0	180	161	1	.003	0.0000
1756.1565	.2216E-21	.006	1631.751	10	5	5	9	6	4	0	1	0	0	0	0	180	161	1	.006	-.0055
1756.4560	.2055E-21	.006	1734.485	4	2	2	3	1	3	0	2	0	0	1	0	180	161	1	.006	-.0018
1756.9843	.3235E-19	.094	552.417	7	1	6	6	2	5	0	1	0	0	0	0	180	161	1	.094	.0017
1757.0351	.7265E-21	.016	1743.432	3	3	1	2	2	0	0	2	0	0	1	0	180	161	1	.016	-.0061
1757.5173	.1745E-21	.005	2442.873	14	5	9	14	4	10	0	1	0	0	0	0	180	161	1	.005	0.0003
1758.3340	.1195E-20	.022	1742.307	3	3	0	2	2	1	0	2	0	0	1	0	180	161	1	.022	-.0020
1758.5922	.4665E-20	.040	1006.116	8	4	5	8	3	6	0	1	0	0	0	0	180	161	1	.040	.0008
1759.0653	.3765E-22	.003	2941.432	9	4	6	9	3	7	0	2	0	0	1	0	180	161	1	.003	.0221
1759.7157	.4095E-21	.011	2414.725	13	4	9	13	3	10	0	1	0	0	0	0	180	161	1	.011	-.0029
1759.4312	.3765E-22	.003																	.003	0.0003
1760.3267	.1767E-20	.023	1839.[illegible]	11	5	6	11	4	7	0	1	0	0	0	0	180	161	1	.023	.0013
1760.3615	.3765E-22	.003	[illegible]	10	7	3	9	8	2	0	1	0	0	0	0	180	161	1	.003	-.0375
1761.[illegible]	[illegible]	.018	[illegible]	9	3	7	9	2	8	0	1	0	0	0	0	180	161	1	.018	.0004
1761.1456	.1565E-21	.004	741.315	9	1	9	8	[illegible]	[illegible]	0	1	0	0	0	0	16	181	1	.004	-.0204
1761.8782	[illegible]	.109	333.457	6	2	5	5	1	4	0	1	0	0	0	0	180	161	1	.109	.0009
1762.[illegible]	[illegible]	.022	[illegible]	8	2	7	7	1	6	0	2	0	0	1	0	180	161	1	.022	-.0013
1762.[illegible]	[illegible]	.007	1724.727	11	4	9	10	[illegible]	[illegible]	0	1	0	0	0	0	180	161	1	.007	-.0022
1764.1516	.4765E-22	.003	133.676	3	3	0	2	2	1	0	1	0	0	0	0	16	181	1	.003	.0015
1764.[illegible]	[illegible]	.004	4033.471	11	5	6	11	4	7	0	2	0	0	1	0	[illegible]	141	1	.004	0.0000
1764.5341	[illegible]	.022	[illegible]	11	[illegible]	11	10	1	10	0	2	0	0	1	0	180	161	1	.022	-.0041
1764.[illegible]	[illegible]	.014	[illegible]	11	[illegible]	11	10	0	10	0	2	0	0	1	0	180	161	1	.014	-.0075
1765.[illegible]	.7417E-21	.006	[illegible]	10	3	8	10	2	9	0	2	0	0	1	0	180	161	1	.006	.0083
1765.[illegible]	.4235E-21	.014	1293.[illegible]	10	2	8	10	1	9	0	1	0	0	0	0	180	161	1	.014	.0002
1766.7172	[illegible]	.003	2673.[illegible]	14	4	11	13	3	[illegible]	0	1	0	0	0	0	180	161	1	.003	-.0002
1767.[illegible]	.1155E-20	.018	1216.[illegible]	9	4	6	9	3	7	0	1	0	0	0	0	180	161	1	.018	-.0006
1767.[illegible]	.1265E-21	.018	[illegible]	5	2	4	6	4	3	0	0	1	0	1	0	180	161	1	.018	-.0005
1767.[illegible]	[illegible]	.027	321.163	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9	0	1	0	0	0	0	180	161	1	.027	-.0020
1767.[illegible]	[illegible]	.023	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	2	0	0	1	0	180	161	1	.023	-.0025

1768.1224	.6322E-13	.123	744.165	9	[illegible]	9	9	1	8	0	1	0	0	0	0	180	161	1	.109	-.0024
1768.3127	.2193E-13	.152	744.064	9	4	9	8	3	8	0	1	0	0	0	0	180	161	1	.052	.0013
1769.3511	.6046E-21	.013	2630.194	9	2	7	8	3	6	0	2	0	0	1	0	180	161	1	.013	-.0021
1769.6069	.3456E-21	.028	3072.728	10	4	7	10	3	8	0	2	0	0	1	0	180	161	1	.005	.0012
1769.9920	.4075E-21	.039	3135.766	11	2	9	11	1	10	0	2	0	0	1	0	180	161	1	.008	-.0080
1770.3339	.1935E-20	.014	321.211	9	2	9	9	1	9	0	1	0	0	0	0	180	161	1	.014	.0001
1770.8551	.2836E-21	.008	135.761	3	3	0	3	0	3	0	1	0	0	0	0	180	161	1	.005	-.0001
1770.9495	.3846E-21	.018	1615.452	10	5	5	10	4	6	0	1	0	0	0	0	180	161	1	.019	.0015
1771.1052	.5566E-21	.013	3744.601	15	5	10	15	4	11	0	1	0	0	0	0	180	161	1	.013	-.0012
1771.2897	.1195E-19	.075	135.164	3	3	1	2	2	0	0	1	0	0	0	0	180	161	1	.075	-.0017
1771.8445	.4316E-21	.011	1998.996	12	4	9	11	5	6	0	1	0	0	0	0	180	161	1	.010	-.0005
1772.7203	.4075E-19	.140	134.902	3	3	0	2	2	1	0	1	0	0	0	0	180	161	1	.140	-.0053
1775.3484	.2865E-21	.007	1875.464	11	5	7	10	6	4	0	1	0	0	0	0	180	161	1	.007	-.0065
1775.2977	.1715E-21	.004	2705.097	10	1	9	10	0	10	0	2	0	0	1	0	180	161	1	.004	-.3117
1775.6348	.8926E-20	.062	542.506	7	2	6	6	1	5	0	1	0	0	0	0	180	161	1	.062	.0002
1776.1567	.2096E-21	.005	3253.739	10	5	5	10	4	6	0	2	0	0	1	0	180	161	1	.005	.0143
1777.2070	.1515E-21	.004	3877.030	13	3	10	13	2	11	0	2	0	0	1	0	180	161	1	.004	.4310
1777.7373	.3765E-22	.003	316.251	10	1	10	9	0	9	0	1	0	0	0	0	16	161	1	.003	-.0213
1777.8454	.9112E-21	.015	2490.355	9	2	8	8	1	7	0	2	0	0	1	0	180	161	1	.015	.0012
1778.0891	.7716E-21	.011	2705.141	10	2	9	10	1	10	0	2	0	0	1	0	180	161	1	.011	-.0041
1778.3373	.7455E-21	.013	1360.208	12	3	9	12	2	10	0	1	0	0	0	0	180	161	1	.013	-.0213
1778.4196	.2425E-20	.027	1446.129	10	4	7	10	3	8	0	1	0	0	0	0	180	161	1	.027	.0006
1778.5317	.1355E-20	.024	1819.737	4	3	2	3	2	1	0	2	0	0	1	0	180	161	1	.024	-.0017
1778.7575	.4465E-21	.011	1474.981	10	4	6	9	5	5	0	1	0	0	0	0	180	161	1	.011	.0006
1778.8310	.3515E-21	.008	2054.348	11	6	5	10	7	4	0	1	0	0	0	0	180	161	1	.008	-.0030
1779.0925	.2645E-20	.025	1293.634	10	3	8	10	2	9	0	1	0	0	0	0	180	161	1	.025	.0015
1779.1192	.1725E-20	.026	416.696	8	2	6	7	3	5	0	1	0	0	0	0	180	161	1	.026	-.0012
1780.5735	.2946E-20	.039	142.278	4	2	2	3	1	3	0	1	0	0	0	0	180	161	1	.039	-.0005
1780.7471	.8175E-20	.051	703.520	8	1	7	7	2	6	0	1	0	0	0	0	180	161	1	.051	-.0001
1780.8108	.2305E-20	.031	1360.236	9	5	4	9	4	5	0	1	0	0	0	0	180	161	1	.031	.0002
1780.9407	.7855E-20	.015	2015.897	12	0	12	11	1	11	0	2	0	0	1	0	180	161	1	.015	.0193
1780.9316	.5105E-20	.022	2015.976	12	1	12	11	0	11	0	2	0	0	1	0	180	161	1	.022	-.0066
1781.9622	.2145E-20	.030	1122.709	9	3	6	8	4	5	0	1	0	0	0	0	180	161	1	.030	.0003
1783.1461	.9765E-22	.003	701.699	9	2	7	7	1	6	0	1	0	0	0	0	16	161	1	.003	.0069
1783.8550	.2465E-21	.008	222.352	4	3	1	4	0	4	0	1	0	0	0	0	180	161	1	.008	0.0008
1784.0699	.2495E-21	.006	2254.294	11	7	5	10	8	2	0	1	0	0	0	0	180	161	1	.006	.0011
1784.1136	.1935E-21	.005	2254.283	11	7	4	10	9	3	0	1	0	0	0	0	180	161	1	.005	.0004
1784.8855	.1985E-19	.052	320.211	10	0	10	9	1	9	0	1	0	0	0	0	180	161	1	.052	-.0005
1784.9769	.3625E-21	.009	1874.974	11	5	6	10	5	5	0	1	0	0	0	0	180	161	1	.009	-.0028
1784.9343	.3355E-21	.003	1913.749	4	3	1	3	2	2	0	2	0	0	1	0	180	161	1	.003	.0032
1784.9772	.5915E-19	[illegible]	123.159	10	1	10	9	[illegible]	9	0	1	0	0	0	0	180	161	1	.089	-.0012
1785.6764	.5515E-22	.002	7136.415	11	2	9	11	2	10	0	2	0	0	1	0	180	161	1	.002	.0122
1785.8123	.1405E-21	.004	2739.446	14	4	10	14	3	11	0	1	0	0	0	0	180	161	1	.004	-.0150
1785.9950	.3945E-21	.008	2338.758	9	5	4	9	4	5	0	2	0	0	1	0	180	161	1	.008	-.0021
1788.2633	.2765E-21	.007	2131.144	8	5	3	8	6	2	1	0	0	0	1	0	180	161	1	.007	-.0023
1788.3579	.1205E-20	.021	1131.776	9	5	3	9	4	4	0	1	0	0	0	0	180	161	1	.021	-.0009
1788.5143	.1495E-20	.014	1114.534	10	1	[illegible]	10	0	10	0	1	0	0	0	0	180	161	1	.014	-.0013
1789.7305	.1175E-20	.015	2537.595	10	1	[illegible]	9	[illegible]	9	0	2	0	0	1	0	180	161	1	.015	-.0116
1789.8791	.3895E-20	.022	1114.553	10	2	9	10	1	10	0	1	0	0	0	0	180	161	1	.022	.0003
1790.0383	.2355E-20	.021	1824.969	11	2	9	11	1	10	0	1	0	0	0	0	180	161	1	.021	-.0003
1790.3637	.2315E-19	.102	764.214	8	2	7	7	1	6	0	1	0	0	0	0	180	161	1	.102	.0003
1792.1810	.5285E-21	.013	1835.071	11	4	8	11	3	9	0	1	0	0	0	0	180	161	1	.013	-.0029
1792.3650	.7115E-20	.025	3765.598	15	6	9	15	5	10	0	1	0	0	0	0	180	161	1	.025	.0050
1792.6607	.3125E-19	.124	112.156	4	3	2	3	2	1	0	1	0	0	0	0	180	161	1	.124	.0003
1792.9727	.3175E-20	.035	511.237	7	5	[illegible]	7	4	3	0	1	0	0	0	0	180	161	1	.035	-.0007
1794.0427	[illegible]	.005	1123.804	11	[illegible]	11	10	1	10	0	1	0	0	0	0	16	161	1	.005	-.0003
1795.1003	.1315E-20	.021	[illegible]	6	[illegible]	[illegible]	5	4	2	0	1	0	0	0	0	180	161	1	.021	-.0003
1795.1493	.3175E-20	.021	[illegible]	10	2	9	[illegible]	1	8	0	2	0	0	1	0	180	161	1	.021	-.0025
1795.8027	.1445E-20	.021	611.741	5	5	[illegible]	5	4	1	0	1	0	0	0	0	180	161	1	.021	.0003
1796.0276	.1755E-20	.022	520.116	5	5	[illegible]	5	4	2	0	1	0	0	0	0	180	161	1	.022	.0004
1796.1723	[illegible]	[illegible]	526.445	6	6	2	6	4	3	0	1	0	0	0	0	180	161	1	.035	.0007
1796.2980	.1245E-20	.020	327.744	7	5	3	7	4	4	0	1	0	0	0	0	180	161	1	.020	.0010
1796.4733	.6285E-21	.009	2144.147	12	5	8	11	5	5	0	1	0	0	0	0	180	161	1	.009	.0001
1796.4473	.4575E-21	.011	2577.140	7	5	2	7	4	3	0	2	0	0	1	0	180	161	1	.011	-.0003
1796.5322	.5225E-21	.013	1022.302	5	3	3	4	2	2	0	2	0	0	1	0	180	161	1	.013	-.0022

1796.3255	.312E-20	.032	1122.703	9	5	4	8	4	5	0	1	0	0	0	0	180	161	1	.032	-.0005
1797.1275	.465E-20	.017	3166.573	13	0	13	12	1	12	0	2	0	0	1	0	180	161	1	.017	.0084
1797.3532	.162E-20	.010	3144.573	13	1	13	12	0	12	0	2	0	0	1	0	180	161	1	.010	.0278
1797.[illegible]	.376E-22	.003																	.003	0.0000
1798.1342	.479E-21	.013	1525.137	11	3	9	11	2	10	0	1	0	0	0	0	180	161	1	.013	-.0002
1798.1375	.135E-21	.004	2339.165	6	5	1	6	4	2	0	2	0	0	1	0	180	161	1	.004	-.0005
1798.5915	.113E-20	.019	1340.886	9	6	6	9	4	6	0	1	0	0	0	0	180	161	1	.019	.0005
1798.6525	.221E-21	.006	2351.863	5	5	0	5	4	1	0	2	0	0	1	0	180	161	1	.006	-.0006
1798.9046	.551E-22	.002	2351.696	5	6	1	5	4	2	0	2	0	0	1	0	180	161	1	.002	-.0004
1798.9572	.636E-21	.013	2339.382	6	5	2	6	4	3	0	2	0	0	1	0	180	161	1	.013	-.0012
1799.0382	.176E-21	.005	2569.608	7	5	3	7	4	4	0	2	0	0	1	0	180	161	1	.005	.0030
1799.3789	.316E-21	.008	2764.699	8	5	4	8	4	5	0	2	0	0	1	0	180	161	1	.008	-.0038
1799.5160	.853E-20	.064	205.301	4	3	1	3	2	2	0	1	0	0	0	0	180	161	1	.064	0.0000
1800.3199	.376E-22	.003	2933.324	9	5	5	9	4	6	0	2	0	0	1	0	180	161	1	.003	-.0109
1801.3260	.574E-19	.074	1114.550	11	0	11	10	1	10	0	1	0	0	0	0	180	161	1	.074	0.0000
1801.3621	.201E-19	.044	1114.534	11	1	11	10	0	10	0	1	0	0	0	0	180	161	1	.044	.0009
1801.6055	.396E-22	.003	2943.414	14	6	8	14	5	9	0	1	0	0	0	0	180	161	1	.003	.0075
1801.9293	.212E-20	.024	1591.336	10	5	6	10	4	7	0	1	0	0	0	0	180	161	1	.024	.0002
1802.4915	.257E-19	.083	995.600	9	1	8	8	2	7	0	1	0	0	0	0	180	161	1	.083	-.0016
1802.7863	.176E-19	.072	2841.632	10	2	8	9	3	7	0	2	0	0	1	0	180	161	1	.072	.0377
1802.9949	.551E-22	.002	326.525	4	4	0	5	1	5	0	1	0	0	0	0	180	161	1	.002	-.0009
1803.7962	.376E-22	.003	2321.814	12	6	6	11	7	5	0	1	0	0	0	0	180	161	1	.003	.0029
1804.4995	.376E-22	.003																	.003	0.0000
1805.[illegible]75	.482E-21	.012	325.368	5	3	2	5	0	5	0	1	0	0	0	0	180	161	1	.012	-.0003
1805.9252	.376E-21	.010	1321.599	6	2	3	4	1	4	0	2	0	0	1	0	180	161	1	.010	-.0012
1805.9254	.795E-21	.012	2243.988	13	3	10	13	2	11	0	1	0	0	0	0	180	161	1	.012	-.0014
1807.0836	.148E-21	.004	2522.267	12	7	6	11	8	3	0	1	0	0	0	0	180	161	1	.004	-.0014
1807.4851	.736E-21	.013	1843.330	11	5	7	11	4	8	0	1	0	0	0	0	180	161	1	.013	-.1041
1807.5177	[illegible]	0.000	3346.392	12	3	10	12	2	11	0	2	0	0	1	0		161	1	0.000	.0673
1807.7346	.542E-20	.042	882.491	9	2	8	9	1	7	0	1	0	0	0	0	180	161	1	.042	-.0006
1808.3724	.123E-20	.015	1362.538	12	4	9	12	3	10	0	1	0	0	0	0	180	161	1	.015	-.0004
1808.5557	.239E-20	.018	1327.113	11	1	10	11	0	11	0	1	0	0	0	0	180	161	1	.018	.0013
1808.9266	.551E-22	.002																	.002	0.0003
1809.2953	[illegible]	.005	1327.119	11	2	10	11	1	11	0	1	0	0	0	0	180	161	1	.005	.0001
1809.8413	.216E-21	.006	3224.548	11	3	8	10	4	7	0	2	0	0	1	0		161	1	.006	-.0935
1810.1231	.376E-22	.003	1321.459	12	0	12	11	1	11	0	1	0	0	0	0	16	161	1	.003	-.0079
1810.1238	.376E-22	.003	1321.452	12	1	12	11	0	11	0	1	0	0	0	0	16	161	1	.003	.0062
1810.3905	.196E-20	.018	2940.429	11	1	10	10	2	9	0	2	0	0	1	0	180	161	1	.018	.0075
1810.5285	.531E-20	.051	715.779	5	3	2	4	2	2	0	1	0	0	0	0	180	161	1	.051	-.0005
1812.3376	.836E-21	.018	[illegible]57.069	6	3	4	5	2	3	0	2	0	0	1	0	180	161	1	.018	-.0005
1812.2203	.376E-22	.001																	.001	0.0003
1812.2873	.517E-20	.047	[illegible].116	9	2	7	8	3	6	0	1	0	0	0	0	180	161	1	.047	-.0015
1812.8315	.359E-20	.022	3341.175	14	0	14	13	1	13	0	2	0	0	1	0		161	1	.022	.0565
1812.8917	.359E-20	.022	3331.135	14	1	14	13	0	13	0	2	0	0	1	0		161	1	.022	.0785
1813.3536	.339E-21	.009	1774.619	12	2	10	12	1	11	0	1	0	0	0	0	180	161	1	.009	-.0004
1813.7335	.387E-21	.009	2303.147	11	2	10	10	1	9	0	2	0	0	1	0	180	161	1	.009	.0025
1813.8789	.408E-21	.010	2629.337	13	6	7	13	5	8	0	1	0	0	0	0	180	161	1	.010	.0031
1814.0173	.249E-21	.006	[illegible]0.141	15	4	11	15	3	12	0	1	0	0	0	0	180	161	1	.006	-.0059
1814.7157	.367E-21	.018	[illegible].217	5	3	2	4	2	3	0	2	0	0	1	0	180	161	1	.018	-.0012
1814.9457	[illegible]	[illegible]	[illegible]7.501	13	5	9	12	6	6	0	1	0	0	0	0	180	161	1	.002	.0013
1815.5687	.106E-20	.014	3124.368	12	5	8	12	4	9	0	1	0	0	0	0	180	161	1	.014	-.0007
1816.6557	.176E-21	.004	3142.527	12	5	7	11	5	6	0	1	0	0	0	0	180	161	1	.004	.0023
1817.1522	[illegible]	.021	[illegible].719	11	4	7	10	5	6	0	1	0	0	0	0	180	161	1	.021	-.0002
1817.463[illegible]	[illegible]	.072	1327.112	12	0	12	11	1	11	0	1	0	0	0	0	180	161	1	.072	-.0150
[illegible]	[illegible]	.072	1327.110	12	1	12	11	0	11	0	1	0	0	0	0	180	161	1	.072	.0010
[illegible]	[illegible]	[illegible]	[illegible].757	12	3	10	12	2	11	0	1	0	0	0	0	180	161	1	.015	-.0001
1821.7743	[illegible]	[illegible]	[illegible].486	[illegible]	3	7	[illegible]	[illegible]	5	0	1	0	0	0	0	180	161	1	.015	-.0069
1822.4233	[illegible]	[illegible]	[illegible].132	[illegible]	3	5	6	[illegible]	4	0	2	0	0	1	0	180	161	1	.011	-.0003
1822.6256	.376E-22	.003		11	4	7	11	3	[illegible]	0	2	0	0	1	0		161	1	.003	0.0000
1823.7635	.675E-20	.037	[illegible].385	10	1	9	9	2	[illegible]	0	1	0	0	0	0	180	161	1	.037	-.0001
1823.9127	.551E-22	.002	3144.572	12	2	11	12	1	12	0	2	0	0	1	0	180	161	1	.002	.0033
1824.2373	[illegible]	0.000	3611.104	13	6	8	12	7	5	0	1	0	0	0	0		161	1	0.000	-.0320
1824.9150	.476E-21	.011	[illegible].689	12	6	5	12	5	7	0	1	0	0	0	0	180	161	1	.011	-.0017
1825.0328	.153E-19	.099	446.311	5	3	4	5	2	3	0	1	0	0	0	0	180	161	1	.099	-.0008
1825.3437	.201E-19	.065	[illegible].080	10	2	9	9	1	9	0	1	0	0	0	0	180	161	1	.065	-.0007

1826.9743	.246E-21	.006	2249.067	13	4	10	13	3	11	0	1	0	0	0	0	180	161	1	.006	.0041
1826.2514	.279E-21	.006	2626.195	13	5	9	13	4	10	0	1	0	0	0	0	180	161	1	.006	.0015
1828.2085	.364E-21	.005	1557.844	12	1	11	12	0	12	0	1	0	0	0	0	180	161	1	.005	.0005
1828.5127	[illegible]	.001	3655.487	15	0	15	14	1	14	0	2	0	0	1	0		161	1	0.000	.1683
1828.5191	.164E-17	.029	3655.486	15	1	15	14	0	14	0	2	0	0	1	0		161	1	.029	.1679
1828.9330	.191E-21	.005	2756.419	14	5	10	13	6	7	0	1	0	0	0	0	180	161	1	.005	-.0003
1829.1313	.413E-20	.045	274.838	5	2	3	4	1	4	0	1	0	0	0	0	180	161	1	.045	-.0003
1829.9132	.188E-21	.005	2617.801	13	6	7	12	7	6	0	1	0	0	0	0	180	161	1	.005	.0048
1830.1324	.179E-19	.081	503.362	5	3	2	4	2	3	0	1	0	0	0	0	180	161	1	.081	.0005
1830.2213	.334E-21	.011	3136.415	12	1	11	11	2	10	0	2	0	0	1	0	180	161	1	.011	.0027
1830.3586	.254E-21	.006	2413.515	13	7	6	12	8	5	0	1	0	0	0	0	180	161	1	.006	-.0064
1831.7264	.168E-20	.014	3135.765	12	2	11	11	1	10	0	2	0	0	1	0	180	161	1	.014	.0026
1831.8974	.166E-21	.004	2553.883	14	3	11	14	2	12	0	1	0	0	0	0	180	161	1	.004	-.0014
1831.9946	.364E-21	.019	2392.594	8	3	6	7	2	5	0	2	0	0	1	0	180	161	1	.019	-.0026
1832.9272	.589E-21	.011	3372.728	11	2	9	10	3	8	0	2	0	0	1	0	180	161	1	.011	-.0052
1833.2865	.576E-19	.063	1557.950	13	0	13	12	1	12	0	1	0	0	0	0	180	161	1	.063	.0002
1833.2935	.576E-19	.060	1557.944	13	1	13	12	0	12	0	1	0	0	0	0	180	161	1	.060	.0095
1834.1495	.508E-21	.013	1399.995	11	6	5	11	5	6	0	1	0	0	0	0	180	161	1	.013	.0005
1834.7785	.136E-20	.011	2042.312	13	2	11	13	1	12	0	1	0	0	0	0	180	161	1	.011	-.0005
1835.8949	.376E-22	.003	445.697	6	3	3	6	0	6	0	1	0	0	0	0	180	161	1	.003	-.0003
1837.1416	.379E-20	.040	652.774	7	3	5	6	2	4	0	1	0	0	0	0	180	161	1	.040	.0005
1837.3473	.502E-21	.008	2042.374	13	3	11	13	2	12	0	1	0	0	0	0	180	161	1	.008	-.0023
1838.1382	.376E-22	.003	2415.144	5	3	3	5	5	0	0	0	1	0	1	0	180	161	1	.003	.0223
1839.1440	.157E-20	.023	1967.617	4	4	1	3	3	0	0	2	0	0	1	0	180	161	1	.023	-.0020
1839.3254	.870E-21	.016	1307.452	4	4	0	3	3	1	0	2	0	0	1	0	180	161	1	.016	-.0014
1840.2943	.496E-21	.011	1724.737	10	6	4	10	5	5	0	1	0	0	0	0	180	161	1	.011	-.0013
1841.1249	.255E-21	.007	2595.813	9	3	7	8	2	6	0	2	0	0	1	0	180	161	1	.007	.0081
1841.5507	.177E-21	.005	3943.521	13	4	9	12	5	8	0	2	0	0	1	0		161	1	.005	-.2473
1842.1726	.152E-19	.051	1293.634	11	1	10	10	2	9	0	1	0	0	0	0	180	161	1	.051	-.0006
1842.1680	.222E-20	.025	1216.232	10	2	8	9	3	7	0	1	0	0	0	0	180	161	1	.025	0.0000
1843.3952	.731E-20	.034	1243.019	11	2	10	10	1	9	0	1	0	0	0	0	180	161	1	.034	.0008
1843.7169	.127E-20	.019	1477.297	9	6	3	9	5	4	0	1	0	0	0	0	180	161	1	.019	-.0009
1843.9477	.394E-20	.014	3337.576	16	0	16	15	1	15	0	2	0	0	1	0		161	1	.014	.3083
1843.9477	.344E-20	.014	3337.575	16	1	16	15	0	15	0	2	0	0	1	0		161	1	.014	.3123
1844.1824	.296E-19	.106	245.419	4	4	1	3	3	0	0	1	0	0	0	0	180	161	1	.106	-.0014
1844.4001	.893E-20	.359	285.219	4	4	0	3	3	1	0	1	0	0	0	0	180	161	1	.359	-.0011
1844.5691	.467E-21	.003	2551.486	14	4	11	14	3	12	0	1	0	0	0	0	180	161	1	.003	-.0011
1844.8325	.551E-22	.002																	.002	0.0000
1845.2310	.670E-21	.013	1259.913	8	6	2	8	5	3	0	1	0	0	0	0	180	161	1	.013	0.0000
1845.2731	.551E-22	.002	3659.906	11	6	5	11	5	6	0	2	0	0	1	0	180	161	1	.002	-.0241
1845.3308	.496E-21	.010	888.632	6	6	0	6	5	1	0	1	0	0	0	0	180	161	1	.010	.0022
1845.3647	.121E-20	.017	889.593	5	5	1	6	5	2	0	1	0	0	0	0	180	161	1	.017	.0013
1845.5945	.146E-20	.020	1053.875	7	6	1	7	5	2	0	1	0	0	0	0	180	161	1	.020	.0004
1845.7943	.797E-21	.014	1159.647	7	6	2	7	5	3	0	1	0	0	0	0	180	161	1	.014	-.0003
1845.8572	.700E-20	.029	1474.981	9	6	4	9	5	5	0	1	0	0	0	0	180	161	1	.029	-.0052
1845.9572	.706E-20	.029	1365.167	8	6	3	8	5	4	0	1	0	0	0	0	180	161	1	.029	-.0003
1845.9866	.311E-21	.015	1719.719	10	6	5	10	5	6	0	1	0	0	0	0	180	161	1	.015	.0004
1846.1323	.264E-21	.005	2327.339	14	6	9	13	7	6	0	1	0	0	0	0	180	161	1	.005	.0031
1846.4664	.230E-21	.006	1485.748	11	6	6	11	5	7	0	1	0	0	0	0	180	161	1	.005	.0005
1847.2734	.137E-20	.009	1466.672	13	1	12	13	0	13	0	1	0	0	0	0	180	161	1	.009	-.0014
1847.5433	.424E-21	.005	1466.673	13	2	12	13	1	13	0	1	0	0	0	0	180	161	1	.005	.0017
1847.7836	.764E-20	.058	792.410	8	3	6	7	2	5	0	1	0	0	0	0	180	161	1	.058	.0004
1847.9166	.554E-21	.011	2275.373	12	6	7	12	5	8	0	1	0	0	0	0	180	161	1	.011	.0003
1848.8149	.388E-19	.047	1935.673	14	0	14	13	1	13	0	1	0	0	0	0	180	161	1	.047	-.0029
1848.8149	.388E-19	.047	1935.672	14	1	14	13	0	13	0	1	0	0	0	0	180	161	1	.047	.0001
1849.5735	.116E-20	.011	3733.392	13	1	12	12	2	11	0	2	0	0	1	0		161	1	.011	-.1545
1849.6412	.247E-21	.007	2204.150	6	3	4	5	2	4	0	2	0	0	1	0	180	161	1	.007	.0019
1850.8721	.651E-22	.002	2644.573	13	6	8	13	5	9	0	1	0	0	0	0	180	161	1	.002	-.0311
1851.0753	.376E-22	.003	2161.227	9	4	5	9	5	4	1	0	0	0	1	0	180	161	1	.003	-.0003
1851.2325	.265E-21	.007	2813.303	10	3	8	9	2	7	0	2	0	0	1	0	180	161	1	.007	.0085
1851.8490	.306E-21	.008	2473.807	13	5	8	12	6	7	0	1	0	0	0	0	180	161	1	.008	-.0020
1852.3610	.651E-22	.002	3127.862	14	7	8	13	8	5	0	1	0	0	0	0	180	161	1	.002	.0020
1853.4062	.551E-22	.002	799.457	5	4	1	5	1	4	0	1	0	0	0	0	180	161	1	.002	-.0002
1854.1700	.376E-22	.003	2552.858	6	6	1	6	5	2	0	2	0	0	1	0	180	161	1	.003	-.0010
1854.8115	.376E-22	.003	2724.168	7	6	1	7	5	2	0	2	0	0	1	0	180	161	1	.003	-.0015

1855.1179	.551E-22	.002																	.002	0.0000
1855.1731	.551E-22	.002	2919.634	8	6	3	[illegible]	5	4	0	2	0	0	1	0	180	161	1	.002	.0099
1855.5065	.551E-22	.002	2327.891	14	2	12	14	1	13	0	1	0	0	0	0	180	161	1	.002	-.0055
1855.7991	.302E-21	.006	2014.244	14	5	9	14	5	10	0	1	0	0	0	0	180	161	1	.005	.0013
1855.9464	.243E-21	.005	2872.274	15	3	12	15	2	13	0	1	0	0	0	0	180	161	1	.005	.0002
1856.2635	.551E-22	.002	542.906	6	4	2	6	1	5	0	1	0	0	0	0	180	161	1	.002	-.0005
1856.9182	.427E-21	.007	2327.914	14	2	12	14	2	13	0	1	0	0	0	0	180	161	1	.007	.0028
1857.6253	.261E-21	.007	1985.788	12	4	8	11	5	7	0	1	0	0	0	0	180	161	1	.007	.0001
1858.5200	.234E-21	.030	982.912	9	3	7	8	2	6	0	1	0	0	0	0	180	161	1	.030	0.0000
1858.8266	.200E-21	.005	3323.271	12	2	10	11	3	9	0	2	0	0	1	0	180	161	1	.005	.0074
1859.2010	.179E-20	.009	4237.325	17	0	17	16	1	15	0	2	0	0	1	0		161	1	.009	.5340
1859.2010	.160E-20	.009	4257.324	17	1	17	16	0	16	0	2	0	0	1	0		161	1	.009	.5360
1859.7043	.188E-2[illegible]	.025	1591.336	11	3	8	10	4	7	0	1	0	0	0	0	180	161	1	.025	-.0003
1860.9157	.462E-20	.025	1525.137	12	1	11	11	2	10	0	1	0	0	0	0	180	161	1	.025	-.0007
1861.5329	.141E-19	.041	1524.849	12	2	11	11	1	10	0	1	0	0	0	0	180	161	1	.041	.0001
1862.9563	.508E-21	.012	[illegible]	5	4	2	4	3	1	0	2	0	0	1	0	180	161	1	.012	-.0003
1863.5622	.163E-21	.004	2872.572	15	4	12	18	3	13	0	1	0	0	0	0	180	161	1	.004	-.0042
1863.6912	.141E-21	.004	3059.400	11	[illegible]	9	10	2	8	0	2	0	0	1	0	180	161	1	.004	.0115
1864.3573	.253E-19	.036	2073.519	15	0	15	14	1	14	0	1	0	0	0	0	180	161	1	.036	-.0003
1864.3573	.253E-19	.036	2073.518	15	1	15	14	0	14	0	1	0	0	0	0	180	161	1	.036	.0007
1864.1722	.959E-21	.018	2004.817	5	4	1	4	[illegible]	2	0	2	0	0	1	0	180	161	1	.019	-.0022
1866.2309	.376E-22	.003	2073.519	14	1	13	14	0	14	0	1	0	0	0	0	180	161	1	.003	-.0003
1866.3168	.643E-21	.007	2073.519	14	2	13	14	1	14	0	1	0	0	0	0	180	161	1	.007	-.0008
1866.3816	.273E-20	.035	416.209	6	3	3	5	2	4	0	1	0	0	0	0	180	161	1	.035	.0004
1867.8543	.562E-20	.048	383.862	5	4	2	4	[illegible]	1	0	1	0	0	0	0	180	161	1	.048	-.0013
1867.9248	.346E-21	.009	794.214	7	4	3	7	1	6	0	1	0	0	0	0	180	161	1	.009	.0012
1868.0238	.263E-21	.004	3654.218	14	1	13	13	2	12	0	2	0	0	1	0		161	1	.004	.4082
1868.3563	.477E-21	.012	136.761	4	3	2	3	0	3	0	1	0	0	0	0	180	161	1	.012	.0007
1868.6393	.513E-21	.006	3654.050	14	2	13	13	1	12	0	2	0	0	1	0		161	1	.006	.2177
1868.7278	.630E-20	.033	1446.129	11	2	9	10	3	8	0	1	0	0	0	0	180	161	1	.033	.0002
1869.3462	.193E-19	.088	382.317	5	4	1	4	3	2	0	1	0	0	0	0	180	161	1	.088	-.0002
1870.8058	.548E-22	.047	1241.927	10	3	8	9	2	7	0	1	0	0	0	0	180	161	1	.047	.0002
1875.4656	.378E-21	.004	3641.372	15	2	13	15	1	14	0	1	0	0	0	0	180	161	1	.004	-.0004
1876.6330	.130E-21	.004	586.243	7	3	4	7	0	7	0	1	0	0	0	0	180	161	1	.006	0.0000
1879.0210	.213E-19	.033	2358.305	16	0	16	15	1	15	0	1	0	0	0	0	180	161	1	.033	-.0020
1879.0210	.213E-19	.033	2358.304	16	1	16	15	0	15	0	1	0	0	0	0	180	161	1	.033	-.0010
1879.2978	.123E-19	.036	1774.752	13	1	12	12	2	11	0	1	0	0	0	0	180	161	1	.036	.0012
1879.5935	.503E-20	.022	1774.613	13	2	12	12	1	11	0	1	0	0	0	0	180	161	1	.022	-.0005
1881.0816	.551E-22	.002	1907.617	[illegible]	2	1	3	3	0	1	0	0	0	1	0	180	161	1	.002	-.0036
1882.9711	.166E-21	.004	3211.214	16	4	13	16	3	14	0	1	0	0	0	0	180	161	1	.004	.0009
1883.8431	[illegible]	.005	[illegible]	13	3	10	12	4	9	0	2	0	0	1	0	180	161	1	.005	-.0341
1884.5659	.178E-20	.029	726.625	5	2	4	5	1	5	0	1	0	0	0	0	180	161	1	.029	.0002
1884.9586	.331E-21	.004	[illegible]	15	1	14	15	0	15	0	1	0	0	0	0	180	161	1	.004	-.0005
1885.0211	.743E-21	.016	2131.435	6	4	3	5	3	2	0	2	0	0	1	0	180	161	1	.016	-.0011
1885.3513	[illegible]	.028	1437.969	11	3	8	10	2	9	0	1	0	0	0	0	180	161	1	.025	-.0007
1887.4555	.351E-21	.008	2756.419	13	7	6	13	6	[illegible]	0	1	0	0	0	0	180	161	1	.009	-.0075
1887.5052	.162E-20	.013	3939.749	15	2	14	14	1	13	0	2	0	0	1	0	180	161	1	.013	.0118
1887.7405	.376E-22	.003	3373.874	15	1	14	14	2	13	0	2	0	0	1	0		161	1	.003	-.4485
[illegible]	.376E-21	.003	3083.748	15	2	14	14	1	13	0	2	0	0	1	0		161	1	.003	-.5152
1889.5633	[illegible]	.069	539.910	6	4	3	5	3	2	0	1	0	0	0	0	180	161	1	.069	.0001
1889.6457	.438E-21	.014	2125.467	6	4	2	5	3	3	0	2	0	0	1	0	180	161	1	.014	-.0002
1890.2524	.223E-21	.006	2749.106	14	5	9	13	6	8	0	[illegible]	0	0	0	0		161	1	.006	-.1736
1891.5518	.781E-21	.017	2151.286	[illegible]	[illegible]	4	5	2	5	0	2	0	0	1	0	180	161	1	.017	-.0009
1891.9963	.376E-22	.003	2637.501	12	7	5	12	5	6	0	1	0	0	0	0	180	161	1	.003	.0082
1892.5987	[illegible]	.020	1645.371	12	2	10	11	[illegible]	9	0	1	0	0	0	0	180	161	1	.020	-.0002
[illegible]	[illegible]	[illegible]	2660.450	[illegible]	[illegible]	17	15	1	15	0	1	0	0	0	0	180	161	1	.029	-.0040
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	17	15	0	16	0	1	0	0	0	0	180	161	1	.029	-.0030
1893.7093	[illegible]	[illegible]	1216.134	[illegible]	[illegible]	[illegible]	7	6	1	0	1	0	0	0	0	180	161	1	.029	.0090
1893.7035	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]	7	5	2	0	1	0	0	0	0	180	161	1	.029	.0130
[illegible]	.561E-21	[illegible]	[illegible]	11	7	4	11	5	5	0	1	0	0	0	0	180	161	1	.012	-.0013
1894.8222	.145E-21	.004	3317.653	[illegible]	[illegible]	[illegible]	8	1	8	1	0	0	0	1	0	180	161	1	.004	-.0062
1894.6544	.359E-21	.014	2411.667	8	[illegible]	1	8	5	2	0	1	0	0	0	0	180	161	1	.024	-.0044
1894.6961	.103E-20	.015	2411.612	8	7	2	8	6	3	0	1	0	0	0	0	180	161	1	.015	-.0001
1895.1973	.277E-20	.033	1503.068	6	4	2	5	3	3	0	1	0	0	0	0	180	161	1	.033	.0001
[illegible]	[illegible]	.030	1621.384	6	[illegible]	2	5	5	3	0	1	0	0	0	0	180	161	1	.030	.0015

1895.7317	.331E-21	.011	1581.251	9	7	3	9	6	4	0	1	0	0	0	0	180	161	1	.011	-.2057
1895.7317	.342E-21	.011	3344.935	14	7	8	14	6	9	0	1	0	0	0	0	180	161	1	.011	.0073
1895.4573	.153E-21	.004	2749.106	13	7	7	13	6	8	0	1	0	0	0	0		161	1	.004	-.1760
1895.5165	.157E-20	.021	1843.030	12	7	9	11	4	8	0	1	0	0	0	0	180	161	1	.021	-.0035
1895.5165	.211E-21	.021	[illegible]	12	7	6	12	6	7	0	1	0	0	0	0	180	161	1	.021	.0055
1895.7387	.185E-20	.021	1874.974	10	7	4	10	6	5	0	1	0	0	0	0	180	161	1	.021	.0013
1895.7387	.189E-20	.021	2142.507	11	7	5	11	6	6	0	1	0	0	0	0	180	161	1	.021	.0193
1897.3727	.527E-20	.022	3642.374	14	1	13	13	2	12	0	1	0	0	0	0	180	161	1	.022	.0003
1897.5215	.138E-19	.032	3542.312	14	2	13	13	1	12	0	1	0	0	0	0	180	161	1	.032	.0015
1898.6657	.302E-21	.016	2275.373	13	4	9	12	5	9	0	1	0	0	0	0	180	161	1	.016	-.0007
1901.7573	.765E-20	.041	1692.665	12	3	10	11	2	9	0	1	0	0	0	0	180	161	1	.041	-.0003
1903.9733	.247E-21	.007	2282.591	7	4	4	6	3	3	0	2	0	0	1	0	180	161	1	.007	.0001
1904.3558	.481E-21	.012	222.052	5	3	3	4	3	4	0	1	0	0	0	0	180	161	1	.012	-.0008
1906.2534	.976E-22	.003	4243.162	16	1	15	15	2	14	0	2	0	0	1	0		161	1	.003	-.1694
1906.3463	.881E-21	.007	4243.112	16	2	15	15	1	14	0	2	0	0	1	0		161	1	.007	-.1729
1907.1325	.501E-21	.003	3879.720	14	2	12	13	3	11	0	2	0	0	1	0		161	1	.003	.3575
1907.3595	.276E-20	.035	651.549	7	4	4	6	3	3	0	1	0	0	0	0	180	161	1	.035	.0004
1908.1286	.878E-20	.020	2981.363	18	0	18	17	1	17	0	1	0	0	0	0	180	161	1	.020	-.0004
1908.1286	.791E-20	.028	2981.363	18	1	18	17	0	17	0	1	0	0	0	0	180	161	1	.028	-.0004
1909.9643	.502E-20	.049	552.912	7	3	4	6	2	5	0	1	0	0	0	0	180	161	1	.049	.0001
1913.3475	.756E-21	.010	3677.090	14	3	12	13	2	11	0	2	0	0	1	0	180	161	1	.010	.0025
1914.5924	.765E-20	.036	1962.508	13	2	11	12	3	10	0	1	0	0	0	0	180	161	1	.035	-.0004
1915.1953	.784E-20	.025	2327.914	15	1	14	14	2	13	0	1	0	0	0	0	180	161	1	.025	.0021
1915.2735	.315E-20	.014	2327.891	15	2	14	14	1	13	0	1	0	0	0	0	180	161	1	.014	.0005
1916.5376	.596E-21	.015	2271.712	7	4	3	5	3	4	0	2	0	0	1	0	180	161	1	.015	-.0005
1918.0383	.482E-20	.037	488.134	5	5	1	4	4	0	0	1	0	0	0	0	180	161	1	.037	-.0010
1918.0759	.146E-19	.074	488.108	5	5	0	4	4	1	0	1	0	0	0	0	180	161	1	.074	.0001
1919.9534	.336E-21	.019	2462.876	8	4	4	7	3	4	0	2	0	0	1	0	180	161	1	.019	-.0024
1919.8694	.357E-21	.017	2146.255	5	2	4	6	1	5	1	0	0	0	1	0	180	161	1	.019	.0066
1919.5137	.155E-20	.015	1960.208	13	3	11	12	2	10	0	1	0	0	0	0	190	161	1	.015	-.0013
1919.6868	.174E-21	.004	1079.093	9	4	5	9	1	8	0	1	0	0	0	0	180	161	1	.004	.0012
1920.8357	.374E-21	.009	2129.513	5	5	1	4	4	0	0	2	0	0	1	0	180	161	1	.008	-.0007
1920.3133	.175E-21	.016	2173.600	5	5	0	4	4	1	0	2	0	0	1	0	180	161	1	.016	-.0003
1922.2955	.535E-20	.017	3319.451	19	0	19	18	1	18	0	1	0	0	0	0	180	161	1	.017	-.0025
1922.2955	.564E-21	.017	3319.451	19	1	19	18	0	18	0	1	0	0	0	0	180	161	1	.017	-.0025
1922.3414	.476E-20	.045	842.357	8	4	5	7	3	4	0	1	0	0	0	0	180	161	1	.045	.0005
1923.0862	.253E-20	.030	2630.194	7	3	5	8	3	6	0	0	1	0	1	0	180	161	1	.030	-.0052
1923.1518	.502E-20	.050	648.979	7	4	3	6	3	4	0	1	0	0	0	0	180	161	1	.050	.0002
1924.7354	.133E-21	.004	2042.755	7	2	5	6	1	5	0	2	0	0	1	0	180	161	1	.004	-.0016
1924.3335	.881E-21	.007	4564.114	17	1	16	15	2	15	0	2	0	0	1	0	180	161	1	.007	-.0375
1927.8538	.246E-20	.023	3124.253	13	3	10	12	4	9	0	1	0	0	0	0	180	161	1	.023	.0002
1928.5733	.438E-21	.007	4194.635	15	2	13	14	3	12	0	2	0	0	1	0		161	1	.007	.5585
1929.7083	.169E-21	.005	3673.732	9	4	5	8	3	5	0	2	0	0	1	0	180	161	1	.005	.0202
1930.9683	.142E-21	.004	2784.835	15	5	10	14	6	9	0	1	0	0	0	0	180	161	1	.004	.0011
1931.7643	.376E-21	.003	4183.792	15	3	13	14	2	12	0	2	0	0	1	0		161	1	.003	.9121
1932.9374	.217E-20	.012	2631.282	16	1	15	15	2	14	0	1	0	0	0	0	180	161	1	.012	.0005
1932.3414	.753E-21	.020	2631.272	16	2	15	15	1	14	0	1	0	0	0	0	180	161	1	.020	.0005
1933.1653	.155E-20	.025	1053.138	9	4	6	8	3	5	0	1	0	0	0	0	180	161	1	.025	.0017
1933.5547	.176E-20	[illegible]	3542.755	6	[illegible]	6	[illegible]	1	5	1	0	0	0	1	0	190	161	1	.003	-.0017
1935.3247	.113E-20	.013	2744.367	14	2	12	13	3	11	0	1	0	0	0	0	180	161	1	.013	.0007
1936.2178	.430E-20	.014	3675.116	20	[illegible]	20	19	1	19	0	1	0	0	0	0	180	161	1	.014	-.0013
1936.3178	.386E-20	.014	3675.116	20	1	20	19	0	19	0	1	0	0	0	0	180	161	1	.014	-.0013
1937.4511	.437E-21	.012	3334.672	10	4	7	9	3	6	0	2	0	0	1	0	180	161	1	.012	.0037
1937.3466	[illegible]	.023	2765.388	14	3	12	13	2	11	0	1	0	0	0	0	180	161	1	.023	.0014
1938.7104	.227E-20	[illegible]	2595.529	14	4	10	13	5	9	0	1	0	0	0	0	180	161	1	.006	.0036
1939.1247	.176E-21	[illegible]	1201.332	9	5	4	9	[illegible]	7	0	1	0	0	0	0	180	161	1	.004	.0013
1940.3675	[illegible]	[illegible]	1590.631	8	8	0	8	7	1	0	1	0	0	0	0	180	161	1	.009	-.0005
1940.3375	[illegible]	[illegible]	1503.603	8	8	1	8	7	2	0	1	0	0	0	0	180	161	1	.008	.0005
1941.6237	.225E-20	[illegible]	1782.917	10	4	[illegible]	9	3	6	0	1	0	0	0	0	180	161	1	.035	.0010
1941.8225	.556E-21	[illegible]	1913.543	9	8	1	9	7	2	0	1	0	0	0	0	190	161	1	.011	-.0005
1941.8225	[illegible]	[illegible]	1913.544	9	8	2	9	7	3	0	1	0	0	0	0	180	161	1	.011	.0035
1942.5163	[illegible]	.060	610.341	6	5	2	5	4	1	0	1	0	0	0	0	190	161	1	.060	.0001
1942.5666	.433E-20	.037	611.116	6	5	1	5	4	2	0	1	0	0	0	0	180	161	1	.037	.0004
1943.1410	[illegible]	.005	2254.359	10	8	2	10	7	3	0	1	0	0	0	0	180	161	1	.005	.0013
1943.1410	[illegible]	.005	2254.763	10	8	2	10	7	3	0	1	0	0	0	0	180	161	1	.005	.0010

1943.1633	.264E-21	.016	3054.348	10	8	3	10	7	4	0	1	0	0	0	0	180	161	1	.006	-.0002
1943.4952	.376E-22	.001	3152.253	11	4	8	10	3	7	0	2	0	0	1	0		161	1	.003	-.1112
1944.0383	.376E-22	.003	2927.910	13	4	5	13	7	6	0	1	0	0	0	0	180	161	1	.003	.0105
1944.0716	.246E-21	.015	3321.915	11	8	3	11	7	4	0	1	0	0	0	0	180	161	1	.006	.0030
1944.1413	.705E-21	.039	3321.814	11	8	4	11	7	5	0	1	0	0	0	0	180	161	1	.007	.0020
1944.7457	.149E-21	.034	2612.301	12	8	5	12	7	6	0	1	0	0	0	0	180	161	1	.004	-.0037
1945.3407	.350E-21	.019	447.252	7	2	5	5	1	6	0	1	0	0	0	0	180	161	1	.019	.0013
1945.4779	.722E-21	.014	2251.867	6	5	2	5	4	1	0	2	0	0	1	0	180	161	1	.014	-.0020
1945.6661	.394E-21	.033	3361.696	6	6	1	5	4	2	0	2	0	0	1	0	180	161	1	.009	-.0009
1946.3640	.764E-21	.016	2639.956	9	4	4	7	3	5	0	2	0	0	1	0	180	161	1	.015	-.0060
1946.3640	.758E-21	.016	325.348	6	3	4	5	0	5	0	1	0	0	0	0	180	161	1	.016	.0013
1947.4025	.137E-21	.004	2439.955	8	0	8	7	3	5	1	0	0	0	1	0	180	161	1	.004	.0005
1948.5125	.176E-21	.005	3441.040	12	4	9	11	3	8	0	2	0	0	1	0		161	1	.005	-.1585
1949.2499	.306E-21	.016	1535.150	11	4	8	10	3	7	0	1	0	0	0	0	180	161	1	.016	.0001
1950.2206	.110E-19	.025	2952.396	17	1	16	16	2	15	0	1	0	0	0	0	180	161	1	.025	-.0056
1950.2206	.122E-19	.025	2952.389	17	2	16	16	1	15	0	1	0	0	0	0	180	161	1	.025	.0134
1951.2771	.651E-22	.002	4536.737	16	3	14	15	2	13	0	2	0	0	1	0		161	1	.002	1.2009
1954.9965	.124E-20	.022	815.694	8	4	4	7	3	5	0	1	0	0	0	0	180	161	1	.022	.0005
1955.2504	.235E-20	.017	2551.486	15	2	13	14	3	12	0	1	0	0	0	0	180	161	1	.017	-.0004
1955.3099	.651E-22	.002	2705.141	9	1	9	10	1	10	0	0	1	0	1	0	180	161	1	.002	-.0019
1956.3039	.651E-22	.002	2705.397	9	0	9	10	0	10	0	0	1	0	1	0	180	161	1	.002	.0191
1956.5834	.539E-21	.009	2426.195	14	3	11	13	4	10	0	1	0	0	0	0	180	161	1	.009	.0005
1956.6414	.105E-20	.011	2553.883	15	3	13	14	2	12	0	1	0	0	0	0	180	161	1	.011	-.0014
1957.6561	.167E-20	.023	1413.224	12	4	9	11	3	8	0	1	0	0	0	0	180	161	1	.023	-.0001
1958.8045	.651E-22	.002	2493.355	7	1	6	8	1	7	0	0	1	0	1	0	180	161	1	.002	.0115
1961.1820	.535E-21	.014	709.609	8	3	5	7	2	6	0	1	0	0	0	0	180	161	1	.014	.0010
1963.7284	.651E-22	.002	2462.976	7	2	5	7	3	4	1	0	0	0	1	0		161	1	.002	-.5373
1966.2615	.213E-20	.027	757.790	7	5	3	6	4	2	0	1	0	0	0	0	180	161	1	.027	.0015
1967.2203	.551E-22	.002	4052.817	14	4	11	13	3	10	0	2	0	0	1	0		161	1	.002	-.2165
1967.4497	.504E-20	.041	755.725	7	5	2	6	4	3	0	1	0	0	0	0	180	161	1	.041	.0003
1967.4815	.243E-20	.012	3291.152	18	1	17	17	2	15	0	1	0	0	0	0	180	161	1	.012	-.0055
1967.4815	.243E-20	.012	3291.149	18	2	17	17	1	16	0	1	0	0	0	0	180	161	1	.012	.0035
1968.1711	.564E-21	.011	2105.876	13	4	10	12	3	9	0	1	0	0	0	0	180	161	1	.011	-.0211
1968.4250	.376E-22	.003																	.003	0.0000
1969.3826	.215E-21	.006	2399.166	7	5	3	6	4	2	0	2	0	0	1	0	180	161	1	.006	.0034
1969.7765	.651E-22	.002	1821.599	3	0	3	4	1	4	1	0	0	0	1	0	180	161	1	.002	-.0015
1970.2559	.493E-21	.011	2399.342	7	5	2	6	4	3	0	2	0	0	1	0	180	161	1	.011	-.0003
1973.8919	.376E-22	.003																	.003	0.0003
1974.6089	.186E-21	.004	2872.572	16	2	14	15	3	13	0	1	0	0	0	0	180	161	1	.004	.0071
1975.3487	.135E-20	.014	2872.774	16	3	14	15	2	13	0	1	0	0	0	0	180	161	1	.014	.0047
1976.3411	.300E-21	.007	2919.244	15	4	11	14	5	10	0	1	0	0	0	0	180	161	1	.007	-.0021
1976.7223	.376E-22	.003	4446.496	23	0	23	22	1	22	0	1	0	0	0	0		161	1	.003	0.0000
1976.7223	.376E-22	.003	4446.496	23	1	23	22	0	22	0	1	0	0	0	0		161	1	.003	0.0000
1981.3246	.345E-21	.014	2614.725	14	4	11	13	3	10	0	1	0	0	0	0	180	161	1	.014	.0006
1981.6213	.172E-21	.005	2530.194	9	4	5	8	3	5	0	2	0	0	1	0	180	161	1	.005	-.0003
1982.1397	.351E-21	.017	2746.026	15	3	12	14	4	11	0	1	0	0	0	0	180	161	1	.012	.0023
1984.6554	.376E-22	.003	2009.405	9	9	1	9	8	2	0	1	0	0	0	0	180	161	1	.003	-.0006
1984.6554	.376E-22	.003	2009.405	9	9	0	9	8	1	0	1	0	0	0	0	180	161	1	.003	-.0004
1984.5413	.162E-21	.009	3647.465	19	1	18	18	2	17	0	1	0	0	0	0	180	161	1	.009	-.0029
1984.5413	.162E-21	.009	3647.463	19	2	18	18	1	17	0	1	0	0	0	0	180	161	1	.009	.0021
1986.5581	.651E-22	.002	2554.284	10	9	2	10	8	3	0	1	0	0	0	0	180	161	1	.002	.0009
1986.5581	.651E-22	.002	2554.246	10	9	1	10	9	2	0	1	0	0	0	0	180	161	1	.002	.0009
1988.3367	.291E-20	.033	331.237	8	5	4	7	4	3	0	1	0	0	0	0	180	161	1	.033	.0003
1988.6773	.150E-21	.004	2522.267	11	9	2	11	8	3	0	1	0	0	0	0	180	161	1	.004	-.0090
1988.5770	.150E-21	.004	2522.263	11	9	3	11	8	4	0	1	0	0	0	0	180	161	1	.004	-.0050
1989.3186	.651E-22	.002	2271.778	24	1	24	23	1	23	0	1	0	0	0	0		161	1	.002	0.0000
1989.3184	.651E-22	.002	2271.777	24	1	24	23	0	23	0	1	0	0	0	0		161	1	.002	0.0000
1991.8864	.106E-17	.049	742.276	6	6	1	5	5	0	0	1	0	0	0	0	180	161	1	.049	.0012
1991.8868	.104E-17	.049	742.277	6	6	0	5	5	1	0	1	0	0	0	0	180	161	1	.049	.0052
1991.8869	.525E-21	.049	2577.142	9	5	4	7	4	3	0	2	0	0	1	0	180	161	1	.049	.0062
1992.3385	.265E-20	.023	327.744	8	5	3	7	4	4	0	1	0	0	0	0	180	161	1	.023	.0005
1992.5510	.167E-20	.026	1005.116	9	4	5	8	3	6	0	1	0	0	0	0	180	161	1	.026	.0010
1993.2278	.135E-21	.004	446.637	7	3	5	5	0	6	0	1	0	0	0	0	180	161	1	.004	.0012
1993.5365	.147E-20	.013	3211.264	17	2	15	16	3	14	0	1	0	0	0	0	180	161	1	.013	.0045
1993.3312	.376E-22	.003	3211.256	17	3	15	16	2	14	0	1	0	0	0	0	180	161	1	.003	.0079

1994.4583	[illegible]	[illegible]	2569.5[illegible]	9	5	7	7	6	4	0	2	0	0	1	0	180	161	1	.006	-.0021
1998.5[illegible]	.35[illegible]	[illegible]	2495.15[illegible]	9	3	6	8	2	7	0	2	0	0	1	0	180	161	1	.002	-.0013
1998.7763	.133E-21	[illegible]	2126.4[illegible]	4	2	2	5	3	3	0	0	1	0	1	0	180	161	1	.036	-.0379
1999.3276	.267E-21	.007	[illegible]99.457	6	4	[illegible]	5	1	6	0	1	0	0	0	0	180	161	1	.007	-.0015
2000.2035	.228E-21	[illegible]	[illegible]	6	6	1	5	5	0	0	2	0	0	1	0	180	161	1	.010	-.0005
2001.0172	.102E-21	.005	[illegible]	5	5	0	5	5	1	0	2	0	0	1	0	180	161	1	.005	-.0002

Table II

Newly identified lines of the (010-000) and (020-010) bands.

Transition	Position	
(010-000) band		
$^{21}_{1,21} - {}^{20}_{0,20}$ } $^{21}_{0,21} - {}^{20}_{1,20}$	1949.9147 cm^{-1}	
$^{22}_{1,22} - {}^{21}_{0,21}$ } $^{22}_{0,22} - {}^{21}_{1,21}$	1963.4065	
$^{23}_{1,23} - {}^{22}_{0,22}$ } $^{23}_{0,23} - {}^{22}_{1,22}$	1976.7223	
$^{24}_{1,24} - {}^{23}_{0,23}$ } $^{24}_{0,24} - {}^{23}_{1,23}$	1989.9184	
(020-010) band		
$^{12}_{1,12} - {}^{11}_{0,11}$	1780.9916	
$^{12}_{0,12} - {}^{11}_{1,11}$	1780.9407	
$^{13}_{1,12} - {}^{12}_{2,11}$	1849.5795	
$^{13}_{1,13} - {}^{12}_{0,12}$	1797.0532	
$^{13}_{0,13} - {}^{12}_{1,12}$	1797.0276	
$^{14}_{1,13} - {}^{13}_{2,12}$	1868.0298	
$^{14}_{1,14} - {}^{13}_{0,13}$	1812.8915	
$^{14}_{0,14} - {}^{13}_{1,13}$	1812.8915	blended
$^{15}_{3,13} - {}^{14}_{2,12}$	1931.9649	
$^{15}_{2,13} - {}^{14}_{3,12}$	1928.6794	
$^{15}_{2,14} - {}^{14}_{1,13}$	1888.0332	
$^{15}_{1,14} - {}^{14}_{2,13}$	1887.7405	

Table II (Continued)

Transition	Position
$^{15}_{1,15} - {}^{14}_{0,14}$	1828.5181 cm^{-1}
$^{15}_{0,15} - {}^{14}_{1,14}$	1828.5127
$^{16}_{3,14} - {}^{15}_{2,13}$	1951.2771
$^{16}_{2,15} - {}^{15}_{1,14}$	1906.3849
$^{16}_{1,15} - {}^{15}_{2,14}$	1906.2534
$^{16}_{1,16} - {}^{15}_{0,15}$ } $^{16}_{0,16} - {}^{15}_{1,15}$	1843.9477
$^{17}_{1,17} - {}^{16}_{0,16}$ } $^{17}_{0,17} - {}^{16}_{1,16}$	1859.2010
$^{18}_{1,18} - {}^{17}_{0,17}$ } $^{18}_{0,18} - {}^{17}_{1,17}$	1874.3132
$^{19}_{1,19} - {}^{18}_{0,18}$ } $^{19}_{0,19} - {}^{18}_{1,18}$	1889.3063
$^{20}_{1,20} - {}^{19}_{0,19}$ } $^{20}_{0,20} - {}^{19}_{1,19}$	1904.2398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